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THE NEMATODA AS PARASITES OF AMPHIBIA*

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Interest in the importance of the Nematodes as parasites of Amphibia is of relatively recent origin, although records of their occurrence are found scattered widely throughout the literature since the pioneer work of the early 1800's. In order to make an efficient survey of this field, the writer has accumulated all of the records of the parasite identification and host occurrence that he can find, bringing the record as nearly possible up to date as of 1931. The question of synonymy of both parasites and hosts has been very perplexing, but thanks to the coöperation of many foreign as well as United States collaborators, examination of a great majority of recognizable species of the parasites has been made possible, and through the courtesy of Mr. Parker and Dr. Malcolm Smith of the British Museum (Natural History) the synonymy of host names has been carefully checked.

ASCAROIDEA

The Ascaroidea are represented by a wide variety of forms recorded from every continent, and from a large number of species of Amphibia.

I. The Family Ascaridae is represented by at least three genera of the sub-family Ascarinae and three genera of the sub-family Anisakinae, as follows:

A. Ascarinae:

1. *Orneoascaris*

a. *O. chrysanthemoides* Skrj., 1916. From the intestine of a bufonid taken in Africa. Length: Male, 28–30 mm.; female, 48–51 mm. Width: Male, 0.8 mm.; female, 1.2 mm. Esophagus length: Male, 5.1 mm.; female, 6.54 mm. Head-excretory pore distance: Female, 1 mm. Anus-tail distance: Male, 0.17 mm.; female, sub-terminal. Caudal papillae of male: 7 pairs of stalked pre-cloacals and 4 pairs of sessile post-cloacals. Spicule length: 1.19 mm. Vulva-head distance: 17.5 mm. Eggs: 0.12 by 0.085 mm.

2. *"Ascaris"–s.l.* (Table 1)

a. *A. brevicauda* v. Linst., 1909. From the intestine of *Triturus cristatus* and *T. vulgaris*—Europe.

* Contribution from the Biological Laboratories of Knox College, No. 43.

TABLE I.—*Ascaris s.l.*

All measurements in millimeters	A. brevicauda		A. contorta	A. foecunda	A. trichura	A. tritonis	A. unguiculatus*	
	male	female				female	male	female
Length	28	45	Doubtful	Doubtful	Doubtful	7–8	2.3–2.6	3.2
Width	0.63	1.1					0.24	0.29
Vestibule—Pharynx (length)							0.042	0.048
Esophagus (length)							1.0	1.13
Bulb							0.085–0.1 × 0.1–0.113	0.085–0.1 × 0.1 0.113
Head—nerve ring distance							0.24	0.24
Head—exc. pore "							0.4	0.5
Anus-tail distance							0.113	0.18
Spicule (length	0.48						0.085	
Acc. piece (length)							0.042	
Papillae, number and position	11 pr. precloacal						4 pr. precloacal 1 pr. postcloacal	
Vulva position		Preequatorial				Postequatorial		Postequatorial
Egg size								0.056 × 0.085 (Embryonated)

* Based on Miranda = Synonymy doubtful.

b. *A. contorta* Mehlis, of Crep., 1846. From intestine of *Triturus vulgaris*—Europe.
c. *A. foecunda* Rud., 1819 (=*Aplectana foecunda* (Rud., 1819) Yorke & Maplestone, 1926). From intestine of *Hyla* (sp. ?) and *Ceratophrys cornuta*—Brazil.
d. *A. trichura* Mehlis, 1846. From intestine of *Triturus alpestris* and *T. vulgaris*—Europe.
e. *A. tritonis* Dies., 1861, of Claparède, 1859. From intestine of *Triturus vulgaris*—Europe.
f. *A. unguiculata* Rud., 1819 (= ? *Aplectana unguiculata* (Rud., 1819) Miranda, 1924). From intestine of *Siphonops annulatus* —Brazil. (Larval forms only).

With the possible exception of *A. brevicauda* v. Linst., 1909, these forms are so meagerly described that their status is extremely doubtful, and many of them probably are actually larval forms, as are the following two species.

3. *Agamascaris* (Table 2)

TABLE 2.—*Agamascaris*

All measurements in millimeters	A. enopla	A. odontocephala
Length	49.47	47.37
Width	0.839	0.837
Esophagus length	0.627 (?)	3.329
Anus-tail distance	0.148	0.437

a. *A. enopla* Steiner, 1924. From liver and stomach cysts of *Hyla cinerea*—U. S. A.
b. *A. odontocephala* Steiner, 1924. From liver and stomach cysts of *Amphiuma tridactylum, Hyla cinerea, Rana catesbiana, R. clamitans, R. pipiens,* and *R. sylvatica*—U. S. A.

B. *Anisakinae:*

1. *Angusticaecum* (Table 3)
a. *A. numidicum* (Seurat, 1917) Baylis, 1920. From duodenum of *Rana ridibunda*—Africa. (As Baylis (1916) states, this form is perhaps only an aberrant form of the genus Amplicaecum).

2. *Amplicaecum* (Table 3)
a. *A. africanum* Taylor, 1924. From stomach of *Probreviceps macrodactylus, Bufo regularis, Rana nutti* and "Frog"—Africa.
b. *A. brumpti* Khalil, 1926. From stomach and intestine of *Rana esculenta*—Europe.
c. *A. gedoelsti* Y. & M., 1926. (=*Ascaris bufonis* Gedoelst, 1916). From stomach of "Toad"—Africa.

3. *Porrocaecum*
a. *P. amphiumae* (Leidy, 1856) Walton, 1927. From stomach cysts of *Amphiuma means*—U. S. A. (Larval forms only). Length, 12.012 mm.; width, 0.425 mm.

II. The Heterakidae are less well represented among amphibian hosts, only African and Asiatic forms affording examples.

TABLE 3.

All measurements in millimeters	Angusticaecum and Amplicaecum							
	Ang. numidicum		Amp. africanum		Amp. gedoelsti		Amp. brumpti	
	male	female	male	female	male	female	male	female
Length	30	65	22–30	32–50	17	32–35	44	70
Width	0.385	0.84	0.46–0.68	0.66–1.2	0.72	0.93	0.5	0.75
Esophagus length	4	5.95	3+	4+–5	2.2	4.1	4.38	5.1
Head-nerve ring distance	0.61	0.925	0.65	0.7	0.5	0.8	0.78	1.15
Head-excretory pore distance	0.6	0.925	0.75	0.75	0.55	0.85	0.8	1.2
Head-dorsal papillae distance	0.6	1.61	1.5	1.5	?	?	?	?
Cecum length	2	3.64	3.57	3.5	1.75	3.25	2.3	2.7
Anus-tail distance	0.25	0.36	0.31	0.3	0.255	0.22	0.25	0.25
Spicule length	0.215		0.85		1.01–1.04		0.33	
Papilla, number and position	7 pr. precloacal 4 pr. postcloacal		10–12 pr. precloacal 3 pr. postcloacal		10 pr. precloacal 3 pr. postcloacal		5 pr. precloacal 3 pr. postcloacal	
Head-vulva distance		20		Preequatorial		ant. third		19
Egg sizes		0.088 × 0.14		0.083 × 0.13		0.06 × 0.12		0.064 × 0.11

A. Heterakinae

1. *Meteterakis*

a. *M. govindi* Karve, 1930. From rectum of *Bufo melanostictus*—Burma. Length: Male, 5–5.4 mm.; female, 4.6–6 mm. Width: Male, 0.231–0.287 mm.; female, 0.25–0.3 mm. Pharynx length: Male, 0.0432 mm.; female 0.0544 mm. Esophagus length: Male, 0.66–0.75 mm.; female, 0.85–0.9 mm. Bulb measurement: Male, 0.143×0.19 mm.; female, 0.193×0.3 mm. Head-nerve ring distance: Male, 0.2775 mm.; female, 0.3 mm. Head-excretory pore distance: Male, 0.462 mm.; female, 0.512–0.54 mm. Anus-tail distance: Male, 0.168–0.2 mm.; female, 0.262–0.343 mm. Male sucker 0.0687 mm. in front of cloaca; caudal alae present; spicules equal, 0.27 mm. long; caudal papillae in 3 groups: 4 pairs pre-suctorial, 3 pairs para-suctorial, and 10 pairs post-suctorial. Vulva with an overhanging flap; 2.2–2.8 mm. from head. Eggs; 0.0431×0.075 mm.

2. *Africana*

a. *A. africana* (Gendre, 1909) Trav., 1920. From intestine of *Bufo regularis*—Africa (Nigeria). Length: Male, 4.5–7 mm.; female, 3.15–8 mm. Width: Male, 0.321–0.46 mm.; female, 0.21–0.48 mm. Pharynx length: Male, 0.046–0.05 mm.; female, 0.048–0.06 mm. Esophagus length: Male, 1.12–1.14 mm.; female, 1.05–1.2 mm. Bulb measurement, female, 0.18×0.2 mm. Anus-tail distance: Male, 0.21–0.28 mm.; female, 0.22–0.34 mm. Spicule length, 1–1.73 mm. Sucker diameter, 0.063–0.066 mm. Vulva-tail distance, 1.8–3.67 mm. Eggs; 0.039–0.046×0.06–0.086 mm.

3. *Spinicauda*

a. *S. japonica* Wilkie, 1930. From intestine of "Bull Frog" (*Rana japonica ?*)—Japan. Length: Male, 5.9 mm.; female, 6.15 mm. Width: Male, 0.38 mm.; female, 0.36 mm. Pharynx length: 0.08 mm. in each sex. Esophagus length: Male, 1.1 mm.; female, 1.02 mm. Bulb measurements: Male, 0.17×0.22 mm.; female, 0.21×0.23 mm. Head-excretory pore distance: Male, 0.6 mm.; female, 0.6 mm. Anus-tail distance: Male, 0.3 mm.; female, 0.5 mm. Tail spike length, 0.04–0.05 mm. in each sex. Spicule length, 0.67 mm. Accessory piece length, 0.08 mm. Sucker diameter, 0.06 mm. Caudal papillae: 8 pairs precloacal, 2 pairs para-cloacal, and 3 pairs post-cloacal. Head-vulva distance, 2.4 mm. Eggs; 0.049×0.086 mm.

III. The Kathlaniidae are parasites of cold-blooded forms, but apparently thus far in America have been reported only from amphibian hosts.

1. *Spironoura* (=*Falcaustra*) (Table 4)

a. *S. catesbianae* (Walton, 1929) Walton, 1930. From large intestine of *Rana catesbiana*—U. S. A.

b. *S. cryptobranchi* Walton, 1930 (Female only). From large intestine of *Cryptobranchus alleganiensis*—U. S. A.

c. *S. elongata* (Baird, 1858) Walton, 1932 (=*Leptodera elongata* Baird, 1858). From intestine of *Ambystoma trigrinum*—Mexico.

d. *S. gracilis* Leidy, 1856. From intestine of *Ambystoma tigrinum*—U. S. A.

TABLE 4—*Spironoura*

All measurements in millimeters	S. gracile		S. catesbianae		S. cryptobranchi	
	male	female	male	female	male	female
Length	8	16	3.5–4	4–4.5	N	15–16
Width	?	?	0.175	0.25	o	0.45–0.5
Pharynx length	?	?	0.08	0.08	t	0.1
Esophagus length	?	?	0.75	0.85		1.6
1st bulb length	?	?			K	
2nd bulb length	?	?	0.14	0.17	n	0.165
Nerve ring-head distance	?	?	0.275	0.325	o	0.45–0.5
Exc. pore-head distance	?	?	?	?	w	?
Anus-tail distance	?	?	0.35	0.4	n	2.7
Spicule length	?		0.325			
Acc. piece length	?		Present (Alate, 4 pr. pre-cloacal 7 pr. post-cloacal			
Papillae, number and position	Present					
Vulva-tail distance		Post-equatorial		Post-equatorial		Post-equatorial
Egg sizes		?		1.6–1.7 0.075 × 0.06		2.8–3.9 ?

TABLE 4.—*Spironoura* (*Continued*)

All measurements in millimeters	S. mascula		S. nitida		S. elongata	
	male	female	male	female	male	female
Length	9–10	12–13	8	8–10	16	18.2
Width	0.5	0.5	0.3	0.4–0.5	0.32	0.38
Pharynx length	0.112	0.112	0.071	0.085	0.125	0.125
Esophagus length	1.2	1.6	0.1	0.1	1.62	1.7
1st. bulb length	0.125	0.137	0.09	0.11	0.37×	0.4×
2nd. bulb length	0.187	0.212	0.14	0.17	0.15	0.15
Nerve ring-head distance	0.31	0.37	0.1	0.1	0.25	0.23
Exc. pore-head distance	1.2	1.6	0.1	0.1	?	?
Anus-tail distance	0.22	0.43	0.25	0.26	0.52	1.2
Spicule length	0.45		0.568		0.5625	
Acc. piece length	0.87		Present		0.125 (Alate)	
Papillae, number and position	3 pr. pre-cloacal 1 pr. para-cloacal 6 pr. post-cloacal		1 pr. pre-cloacal 7 pr. post-cloacal		3 pr. pre-cloacal 1 median pre-cloacal 9 pr. post-cloacal	
Vulva-tail distance		Post-equatorial		Post-equatorial		Post-equatorial 7.5
Egg sizes		0.05 × 0.125		0.042 × 0.049		0.05 × 0.1625

e. *S. mascula* (Trav., 1919) Y. & M., 1926 (=*Florencioia mascula* (Rud., 1819) Trav., 1919, =*Ascaris mascula* Rud., 1819). From large intestine of *Elosia nasus*—Brazil.

f. *S. nitida* (Trav., 1919) Y. & M., 1926 (=*Florencioia nitida* Trav., 1919). From large intestine of *Hyla faber* and *Leptodactylus ocellatus*—Brazil.

2. *Zanclophorus*

a. *Z. cryptobranchi* Walton, 1930. From rectum of *Cryptobranchus alleganiensis*—Penn., U. S. A. Length: Male 7 mm.; female, 8.5–9 mm. Width: Male, 0.3 mm.; female, 0.45–0.5 mm. Vestibule length: Male, 0.095–0.1 mm.; female, 0.1 mm. Length of esophagus plus anterior bulb: Male, 1.4 mm.; female, 1.5 mm. Posterior bulb measurements: Male, 0.135×0.16 mm.; female, 0.15×0.175 mm. Head-nerve ring distance, 0.45–0.5 mm. in each sex. Head-excretory pore distance: Male, 0.75 mm.; female, 0.8–0.85 mm. Anus-tail distance: Male, 0.35–0.4 mm.; female, 0.7 mm. Sucker-cloaca distance, 1.8 mm. Spicule length, 0.75 mm. Accessory piece length, 0.15 mm. Caudal papillae: 3 pairs pre-cloacal, 1 single median pre-cloacal, 2 pairs para-cloacal, 5 pairs post-cloacal. Vulva-anus distance: 3.4–3.5 mm. Oviparous. Eggs; 0.06×0.075 mm.

IV. The Oxyascaridae are represented by a single Brazilian species.

1. *Oxyascaris*

a. *O. similis* Trav., 1920. From intestine of *Leptodactylus ocellatus, Bufo crucifer, B. marinus,* and *Hyla faber*—Brazil. Length: Male, 6.5–10 mm.; female, 22–26 mm. Width: Male, 0.28–0.35 mm.; female, 0.43–0.52 mm. Esophagus length: Male, 0.75–1.13 mm.; female, 1.7–1.8 mm. Bulb measurements: Male, 0.15×0.19.; female, 0.22×0.26 mm. Head-nerve ring distance: Male, 0.35 mm.; female, 0.65 mm. Head-excretory pore distance: Male, 0.57–0.66 mm.; female, 0.87 mm. Anus-tail distance: Male, 0.33–0.38 mm.; female, 0.84–1.0 mm. Spicule length, 0.162–0.168 mm. Caudal papillae: 6 pairs pre-cloacal, 1 single median pre-cloacal, 7 pairs post-cloacal. Vulva equatorial. Eggs; 0.078×0.098 mm.

V. The Oxyuridae are perhaps the most cosmopolitan of the parasites as to their distribution, and are represented by far the greatest number of species of any group of the Ascaroidea.

A. Oxyurinae

1. *"Oxyuris" s.l.*

a. *O. bidentata* v. Linst., 1880. From intestine of *Rana* sp.? (larva)—Europe.

b. *O. dubia* Leidy, 1856 (=*Aplectana dubia* (Leidy, 1856) Trav., 1931). From cecum of *Bufo americanus* and *Pseudotriton ruber*—U. S. A.

c. *O. mucronata* Molin, 1858 (larval form only). From intestine of *Bufo bufo*—Europe.

d. *O. tarda* Polonio, 1859. From intestine of *Bufo bufo* and *B. viridis*—Europe.

e. *O.* sp.? Claus, 1872. From an intestinal cyst in *Triturus vulgaris* —Europe.

f. *O.* sp.? Dinnik, 1926. From an intestinal cyst in *Rana macrocnemis*—Europe.

O. bidentata: (Female only) Length, 2.7 mm.; width, 0.32 mm.; esophagus length, 0.5 mm.; bulb present; tail length, 0.51 mm.; head-vulva distance, 1.32 mm.; eggs, 0.05×0.1 mm.

O. dubia: (Female only) Length, 3.18 mm.; width, 0.53 mm.; vulva equatorial.

O. mucronata: (Female only) Length, 1.1–1.5 mm.; width, 0.02 mm.; vulva post-equatorial.

O. tarda Polonio, 1859, *O.* sp.? Claus, 1872, and *O.* sp.? Dinnik, 1926, are not described.

The absence of male material makes accurate generic placement of these forms impossible, and in some cases specific identities are extremely doubtful.

2. *Thelandros*

a. *T. oswaldocruzi* Trav., 1925. From large intestine of *Hyla mesophaea*—Brazil. Length: Male, 2.7 mm.; female, 6.6 mm. Width: Male, 0.2 mm.; female, 0.7 mm. Esophagus length: Male, 0.42 mm.; female, 0.59 mm. Bulb length: Male, 0.09 mm.; female, 0.17 mm. Head-nerve ring distance, 0.15 mm. in each sex. Head-excretory pore distance: Male, 0.85 mm.; female, 1.77 mm. Anus-tail distance: Male, 0.8 mm.; female, 0.7 mm. Spicule length, 0.44 mm. Caudal papillae: 3 pairs post-cloacal, 2 single post-cloacal. Head-vulva distance, 3.3 mm. Eggs; 0.052×0.192 mm.

3. *Parathelandros*

a. *P. mastigurus* Baylis, 1930. From intestine of *Hyla coerulea* and *H. gracilenta*—Australia. Length: Male, 1.3–1.45 mm.; female, 3.24–4.72 mm. Width: Male, 0.14–0.19 mm.; female, 0.22–0.38 mm. Esophagus length: Male, 0.18–0.28 mm.; female, 0.34–0.39 mm. Bulb length: Male, 0.06–0.07 mm.; female, 0.1–0.11 mm. Head-nerve ring distance: Male, 0.1–0.15 mm.; female, 0.125–0.187 mm. Excretory pore in front of vulva in female. Anus-tail distance: Male, 0.27–0.32 mm.; female, 0.9–1.1 mm. Lateral alae present in both sexes. Spicule length, 0.075 mm. Caudal papillae: 1 pair pre-cloacal, 1 pair post-cloacal. Head-vulva distance, 0.16–0.22 mm. Eggs; 0.037–0.047×0.127–0.15 mm.

4. *Pharyngodon* (Table 5)

a. *P. armatus* Walton, 1933. From intestine of *Rana clamitans* and *R. pipiens*—U. S. A.

b. *P. batrachiensis* Walton, 1929. From intestine of larva of *Rana pipiens*—U. S. A.

c. *P. spinicauda* (Duj., 1845) Seurat, 1917 (=*Oxyuris spinicauda* Duj., 1845, =*Ascaris extenuata* Rud., 1819, *ex. p.*, =*Ascaris spinicauda* (Duj., 1845) Dies., 1851, =*Ascaris acanthura* Dies., 1851, *ex. p.*, =*Pharyngodon acanthurus* (Dies., 1851) Dies., 1861, *ex. p.*) From intestine of *Triturus vulgaris*—Europe.

d. *P.* sp.? Wilkie, 1930 (Female only). From intestine of *Onychodactylus japonica, Hynobius kimurae* and *H. stejnegeri*—Japan.

B. *Cosmocercinae*

This sub-family contains a very large number of species belonging to a number of genera, and is the best represented group of parasitic

TABLE 5.—*Pharyngodon*

All measurements in millimeters	P. armatus		P. batrachiensis		P. spinicauda		P. sp.?	
	male	female	male	female	male	female	male	female
Length	Not known	3.5	Not known	4.2	1.6–3	3.1–5	Not known	Not described
Width		0.24		0.365	0.073	0.085		
Esophagus length		0.28		0.56	0.28	0.33		
Bulb (length)		0.15 × 0.15		0.15 × 0.125	0.07	0.074		
Head-nerve ring distance		0.175		0.165	0.13	0.15		
Head-exc. pore distance		0.36		0.61	0.65–0.7	0.78–0.9		
Anus-tail distance		0.5		0.9	0.125	0.75–0.96		
Tail spike (length)		0.5		0.75	0.07	0.65–0.7		
Spicule length					0.06			
Papillae, number and position					2 pr. post-cloacal 1 median post-cloacal			
Head-vulva distance		1.5		1.8		1.5		
Egg sizes		0.06 × 0.1 (4–8 celled)		0.035 × 0.1 (1-celled)		0.051 × 0.155		

nematodes found in amphibian hosts. It is also the most cosmopolitan in its distribution, being represented by examples from all of the continents. This sub-family, in addition to several other genera, contains the two genera, *Aplectana* and *Oxysomatium,* whose present status of contained species is very much in doubt. The scheme followed here is partially based upon that recently advanced by Travassos (1931) for this sub-family, but does not represent the present writer's final conclusions. Study of this group throws extreme doubt upon the position and even validity of many of the species recorded, but until such study is completed, the present schema is tentatively advanced.

1. *Cosmocerca* (Table 6)
   a. *C. brasiliensis* Trav., 1925. From intestine of *Bufo crucifer, Eleutherodactylus gollmeri, E. miliaris* and *Hyla faber*—Brazil.
   b. *C. commutata* (Dies., 1851) Dies., 1861 (=*Oxyuris ornata* Weinland, 1859, =*Nematoxys commutatus* (Dies., 1851) v. Linst., 1889.) From intestine of *Bufo marinus, Hyla luteus* (?), *H. tschudii* (?), and *Leptodactylus typhonius*—Brazil, and from *Bombina bombina, Bufo bufo, B. viridis, Hyla arborea, Pelobates fuscus, Rana esculenta, R. temporaria, Salamandra atra, S. salamandra* and *Triturus cristatus*—Europe.
   c. *C. longicauda* (v. Linst., 1885) Raill. and Henry, 1916 (=*Nematoxys longicauda* v. Linst., 1885). From intestine of *Triturus alpestris, T. cristatus* and *T. vulgaris*—Europe.
   d. *C. minuscula* Trav., 1931. From intestine of *Rana temporaria*—Europe.
   e. *C. ornata* (Duj., 1845) Raill & Henry, 1916 (=*Oxyuris ornata* Duj., 1845, =*Nematoxys ornatus* (Duj., 1845) Schneider, 1866, =*Ananconus commutatus* Raill. & Henry, 1916). From intestine of *Bufo bufo, B. viridis, Rana esculenta, R. temporaria, Triturus alpestris,* and *T. cristatus*—Europe.
   f. *C. parva* Trav., 1925. From intestine of *Elosia nasus*—Brazil.
   g. *C. trispinosa* Raill. & Henry, 1916 (=*Oxyuris ornata* Walter, 1856, =*Cosmocerca ornata* (Walter, 1856, Dies., 1861). Adults from intestines, and larvae from lungs, of *Triturus alpestris*—Europe.

2. *Cosmocercella*
   a. *C. haberi* Steiner, 1924. From intestine of *Hyla cinerea*—U. S. A. Length: Male, 1.76 mm.; female, 1.88 mm. Width: Male, 0.08 mm.; female, 0.099 mm. Esophagus length: Male, 0.408 mm.; female, 0.456 mm. Anus-tail length: Male, 0.136 mm.; female, 0.235 mm. Lateral alae: male, cup-shaped. Spicule length, 0.197 mm. Accessory piece present. Plectanes in male, 4 pairs in 2 rows. Caudal papillae: 6 pairs pre-cloacal, 1 single pre-cloacal, 5 pairs post-cloacal in position. Vulva-tail distance, 0.893 mm. Eggs: 0.082–0.109 mm. × 0.205–0.252 mm.

3. *Cosmocercoides* (Table 7)
   a. *C. dukae* (Holl, 1928) Wilkie, 1930 (=*Cosmocerca dukae* Holl, 1928). From intestine and colon of *Triturus viridescens*—U. S. A.
   b. *C. pulcher* Wilkie, 1930. From rectum of "Bull-frog" (=*Rana japonica* ?)—Japan.

TABLE 6.—*Cosmocerca*

All measurements in millimeters	C. brasiliensis		C. commutata		C. longicauda		C. minuscula	
	male	female	male	female	male	female	male	female
Length	5.5	9	3.9–4.6	4–6.1	2.9	5.3	0.6–0.91	Not known
Width	0.52	0.96	0.48	0.36–0.65	0.24	0.48	0.052–0.099	
Pharynx (length)	0.048	0.072	0.03	0.042	?	?	0.016	
Esophagus (length)	0.6	0.92	0.28–0.4	0.43	0.4	0.662	0.11–0.15	
Bulb (length)	0.1	0.17	0.12 × 0.01	0.18 × 0.15	0.15	0.15	0.04 × 0.03	
Head-exc. pore distance	0.52	0.52	0.35	0.48	Post-bulbar		Pre-bulbar	
Head-nerve ring distance	0.3	0.46	0.2	0.23	?	?	0.096	
Anus-tail distance	0.3	0.6	0.3–0.47	0.12	0.35	1.3	0.092–0.12	
Spicule length	0.15–0.2		0.192–0.224		0.192		Poorly chitinized	
Acc. piece, shape & size	Triangular		Triangular 0.216 × 0.24		Triangular 0.119		Subtriangular 0.056	
Papillae, number & position	3 pr. paracloacal 4 pr. postcloacal		10 pr. postcloacal		2–3 pr. precloacal 10 pr. postcloacal		3 pr. precloacal 2 pr. paracloacal 17 pr. postcloacal	
Plectanes, number & arrangement	2 rows 9–11 pr.		2 rows 14 pr.		2 rows 6 pr.		2 rows 5 pr.	
Vulva-tail distance		4.4		2–3		2.2		
Egg sizes		0.054 × 0.09		0.1 × 0.06		0.08 × 0.12		

TABLE 6 (*Continued*).—*Cosmocerca*

All measurements in millimeters	C. ornata		C. parva		C. trispinosa	
	male	female	male	female	male	female
Length	1.1–4	6–9	3–5	6–8	3–4	3.4–5
Width	0.16–0.27	0.38–0.64	0.18	0.7	0.11	0.13–0.16
Pharynx (length)	0.045	0.042	0.052	0.052	?	?
Esophagus (length)	0.22–0.3	0.3–0.5	0.23	0.64	?	?
Bulb (length)	0.07×0.06	0.16×0.15	0.04	0.17	Present	
Head-exc. pore distance	0.32	0.61	0.2	0.64	Pre-bulbar	
Head-nerve ring distance	?	?	0.1	0.31	Middle of Esophagus	
Anus-tail distance	0.14–0.19	0.4–0.47	0.088	0.56	0.186 (tail 3-tipped)	0.4 (tail 3-tipped)
Spicule length	0.1		0.08		Very short	
Acc. piece, shape & size	Inverted triangle		V-shaped 0.07 × 0.05		Present	
Papillae, number & position	3–7 pr. precloacal 14 pr. postcloacal		?		Numerous	
Plectanes, number & arrangement	2–4 rows 5–8 pr.		2 rows 5-pr.		4 rows 13–14 pr.	
Vulva-tail distance		3–4.5		3–4		1.6–2.3
Egg sizes		0.1×0.068		0.062×0.112		?

TABLE 7.—*Cosmocercoides*

All measurements in millimeters	C. dukae		C. pulcher		C. tridens		C. variabilis	
	male	female	male	female	male	female	male	female
Length	2.55	3.066	6.9	9.0	4.35	N	2.2–5	3.3–6
Width	0.153	0.1645	0.43	0.54	0.44	o	0.15–0.5	0.2–0.5
Pharynx (length)	Present		0.09	0.1	0.082	t	0.042–0.078	0.05–0.075
Esophagus (length)	0.396	0.408	0.95	1.12	0.73	K	0.45–0.8	0.55–0.99
Bulb	0.085 × 0.088	0.077 × 0.091	0.16 × 0.18	0.18 × 0.22	0.12 × 0.12	n o w n	0.12–0.18 × 0.085–0.145	0.146–0.24 × 0.108–0.15
Head-exc. pore distance	?	?	0.75	1.0	0.32		0.3–0.56	0.33–0.55
Head-nerve ring distance	?	?	?	?	?		0.2–0.3	0.22–0.23
Anus-tail distance	0.24	0.124	0.22	0.38	0.2		0.125	0.13–0.3
Lateral alae	none	none	none	none	none		0.22 narrow	narrow
Spicule length	0.29		0.247		0.53		0.25	
Acc. piece length	0.102		0.143		0.14 (3-pronged base)		0.42 0.11–0.13	
Complex papillae, number & position	11 pr. precloacal 1 pr. postcloacal		16–17 pr. precloacal 1 pr. postcloacal		10 pr. precloacal 3 pr. postcloacal		11–17 pr. precloacal 1 pr. paracloacal 2 pr. postcloacal	
Simple papillae, number & position	?		numerous precloacal 8 pr. postcloacal		numerous		1 single precloacal 4 pr. postcloacal	
Vulva-head distance		1.826		5.0				2–3.5
Egg sizes		?		0.049 × 0.082				0.045× 0.08

c. *C. tridens* Wilkie, 1930. From rectum of *Tylototriton andersoni* —Japan.

d. *C. variabilis* (Harwood, 1930) Trav., 1931 (=*Cosmocerca variabilis* Harwood, 1930). From rectum of *Ambystoma microstomum, A. opacum, Bufo valliceps, Hyla squirella, Pseudacris triseriata, Rana areolata, R. palustris, R. sphenocephala, R. sylvatica* and *Triturus meridionalis*—U. S. A.

TABLE 8.—*Schrankia*

All measurements in millimeters	S. brasili		S. schranki	
	male	female	male	female
Length	4.6	5–6.2	2.5	2.7
Width	0.2	0.3	0.16	0.16
Pharynx (length)	0.1	0.11	0.05	0.05
Esophagus (length)	1.0	1.2	0.55	0.6
Bulb (length)	0.08	0.1	0.10 × 0.07	0.12 × 0.10
Head-exc. pore distance	0.8	0.9	?	?
Head-nerve ring distance	0.34	0.37	?	?
Anus-tail distance	0.15	0.37	0.17	0.16–0.2
Spicule length	0.77		0.045	
Acc. piece (length)	0.05–0.09		Present	
Papillae, number and position	?		3 pr. precloacal 3 pr. postcloacal	2 vulvar papillae
Vulva-tail distance		0.55–0.62		0.35–0.37
Egg size		0.225–0.3 × 0.425–0.475		0.1×0.2

4. *Schrankia* (Table 8)

a. *S. brasili* Trav., 1927. From large intestine of *Leptodactylus pentadactylus*—Brazil.

b. *S. schranki* Trav., 1925. From large intestine of *Leptodactylus pentadactylus*—Brazil.

5. *Aplectana* (Table 9)

a. *A. acuminata* (Schrank, 1788) Raill. & Henry, 1916 (=*Ascaris acuminata* Schrank, 1788, =*A. ani* Schrank, 1788, *ex. p.*, =*A. subulata* Schrank, 1788, *ex. p.*, =*A. ranae* Gmel., 1790, =*A. bufonis* Gmel., 1790, *ex. p.*, =*Nematoxys commutatus* Rud., 1819, =*Heterakis acuminata* (Schrank, 1788) Stewart, 1914, =*Aplecta acuminata* (Schrank, 1788) Raill. & Henry, 1916). From large intestine of *Bombina bombina, Bufo bufo, B. viridis, Hyla arborea, Pelobates fuscus, Rana esculenta, R. temporaria, Salamandra atra, S. salamandra, Triturus cristatus* and *T. vulgaris*—Europe; and of *Bufo marinus, Hyla luteus* ?, *H. tschudii*?, and *Leptodactylus typhonius*—Brazil.

b. *A. brumpti* Trav., 1931. From large intestine of *Bufo viridis*—Europe.

c. *A. crucifera* Trav., 1925. From large intestine of *Bufo crucifer* —Brazil.

d. *A. micropenis* Trav., 1925. From large intestine of *Elosia nasus* —Brazil.

e. *A. pintoi* Trav., 1925. From large intestine of *Eleutherodactylus gollmeri*—Brazil.

f. *A. schneideri* Trav., 1931. (=*Ascaris commutata* Claparède, 1859, =*Nematoxys commutatus* (Clap., 1859) (Schn., 1866). From large intestine of *Rana temporaria*—Europe.

TABLE 9.—*Aplectana*

All measurements in millimeters	A. acuminata		A. brumpti		A. crucifera		A. micropenis		A. pintoi	
	male	female	male	female	male	female	male	female	male	female
Length	2	5–13	2.6–2.8	3.4–4.2	3.5	4.2	2.5	?	1.8	Not Known
Width	0.17	0.25–0.4	0.15–0.21	0.23–0.28	0.45	0.66	0.24	?	0.28	
Pharynx (length)	0.035	0.035	0.032	0.042	0.04	0.07	0.07	?	0.028	
Esophagus (length)	0.35	0.35	0.35	0.42	0.5	0.7	0.41–0.5	?	0.29	
Bulb (length)	0.11	0.11	0.07×0.12	0.12×0.15	0.14	0.17	0.08×0.1	?	0.085	
Head-exc. pore distance	?	?	0.4	0.45	0.5	0.7	?	?	0.22	
Head-nerve ring distance	?	?	0.22	0.31	0.25	0.35	0.2–0.25	?	0.15	
Anus tail distance	0.25	0.7	0.14–0.2	0.29–0.31	0.42	0.56	0.27	0.51	0.41	
Spicule length	0.25		0.2–0.23		0.33		0.06		0.09–0.1	
Acc. piece, shape & size	Present		0.04		Absent		Crescentic		Absent	
Papillae, number and position	12 pr. postcloacal		12 pr. precloacal 8 pr. postcloacal		6 pr. precloacal 1 pr. paracloacal 4 pr. postcloacal		4 pr. precloacal 1 pr. postcloacal		3 pr. precloacal 1 pr. paracloacal 3 pr. postcloacal	
Vulva-tail distance		Preequatorial		Postequatorial		2.1 Equatorial		Equatorial		
Egg size		0.14–0.17		0.072–0.096×0.056		0.095×0.056		0.125×0.075		

TABLE 9 (Con.)—*Aplectana*

All measurements in millimeters	A. schneideri		A. stromi		A. vellardi		A. sp? Trav.		A. sp? Wilkie		A. sp?	
	male	female	male	female	male	female	male	female	male	female	male	female
Length	2.8–3.1	Not	Not	4.6–4.8	3.5	4.3	Not	Not	Not	Not	Not	6
Width	0.28–0.31			0.34–0.39	0.3	0.37						0.37
Pharynx (length)	0.02–0.024	Known	Known	0.04	0.038	0.038	Known	Described	Known	Described	Known	0.05
Esophagus (length)	0.28–0.3			0.28–0.3	0.36	0.38						0.55
Bulb (length)	0.12–0.13× 0.07–0.08			0.14× 0.1–0.12	0.1	0.12						0.18
Head-exc. pore distance	0.27–0.28			?	Prebulbar ?	Prebulbar ?						0.55
Head-nerve ring distance	0.18			0.15–0.17								0.4
Anus-tail distance	0.2–0.21			0.52	0.44	0.4						0.4
Spicule length	0.024–0.028				0.169–0.192							
Acc. piece	Absent				Absent							
Papillae, number and position	7 pr. paracloacal 9 pr. postcloacal			scattered all over body	2 pr. precloacal 2 pr. paracloacal 6 pr. postcloacal							
Vulva-tail distance				Postequatorial		Equatorial						4 Preequatorial
Egg size				?		0.084 0.092× 0.053						0.075 × 0.055

g. *A. stromi* Trav., 1931. From intestine of *Rana esculenta*—Russia.
h. *A. vellardi* Trav., 1926. From large intestine of *Bufo marinus, Eleutherodactylus gollmeri, E. miliaris* and *Elosia nasus*—Brazil.
i. *A.* sp.? Trav., 1925 (Female only). From intestine of *Eleutherodactylus binotatus, E. miliaris, Hyla crepitans, H. langsdorffi, H. mesophaea,* and *H. microps*—Brazil.
j. *A.* sp.? Wilkie, 1930 (Female only). From intestine of *Triturus pyrrhogaster*—Japan.
k. *A.* sp.? (This paper, female only). From intestine of *Hynobius fuscus*—Japan.

Female specimens of a probable species of *Aplectana* were placed at the disposal of the writer through the courtesy of Dr. H. A. Baylis of the British Museum (Natural History). Like the forms mentioned by Wilkie (1930), these come from Japan. The host is *Hynobius fuscus.* Although no species designation is advisable, the description of this form differs materially from that of the females of the known species of *Aplectana* and is as follows:

Female: Lips tri-lobed, each lobe possessing terminal and basal papillae. Body length averages 6 mm., and width at vulva 0.37 mm. Short pharynx, 0.05 mm. in length, opens into an esophagus 0.55 mm. long; this in turn ends in a bulb 0.18 mm. in diameter. Nerve-ring 0.4 mm. from anterior end, and excretory pore 0.55 mm. Anus-tail distance, 0.4 mm. Vulva opens 2 mm. from anterior end of body. Ovaries prodelphous. Mature eggs 0.075 mm. by 0.055 mm.; contain coiled larvae.

The material described is in the collection of the British Museum (Natural History), No. 3.12.71–73.1931.

6. *Oxysomatium* (Table 10)

a. *O. americana* (Walton, 1929) (=*Aplectana americana* Walton, 1929). From cecum of *Rana catesbiana, R. palustris, R. pipiens* and *Scaphiopus couchii*—U. S. A.
b. *O. baylisi* (this paper). From rectum of *Ceratophrys dorsata*—Brazil.
c. *O. brevicaudatum* (Zed., 1800) Raill. & Henry, 1916 (=*Ascaris ani* Schrank, 1788, *ex. p.*, =*A. acuminata* Schrank, 1788, *ex. p.*, =*A. bufonis* Gmel., 1790, *ex. p.*, =*A. salamandrae* Schrank, 1790, =*Fusaria brevicaudata* Zeder, 1800, =*F. salamandrae* (Schrank, 1790) Zed., 1803, =*Ascaris salamandrae-terrestris* Rud., 1809, =*A. brevicaudata* (Zed., 1800) Rud., 1819, *ex. p.*, =*Heterakis brevicaudata* (Zed., 1800) Duj., 1845, =*H. acuminata* (Schrank, 1788) Duj., 1845, *ex. p.*, =*Cosmocerca commutata* (Dies., 1851) Dies., 1861, *ex. p.*, =*Oxysoma brevicaudatum* (Zed., 1800) Schn., 1866, =*Aplecta brevicaudata* (Zed., 1800) Raill. & Henry, 1916, =*Oxysomatium longispiculum* Raill. & Henry, 1916, *ex. p.*). From rectum of *Bombina bombina, Bufo bufo, B. viridis, Hyla arborea, Pelobates fuscus, Rana esculenta, R. temporaria, Salamandra atra,* and *S. salamandra*—Europe; and from *Pseudotriton ruber*—U. S. A.
d. *O. contortum* (v. Linst., 1906) Skrj., 1916 (=*Oxysoma contortum* v. Linst., 1906). From intestine of *Bufo bufo*—Europe (Corfu).
e. *O. dogieli* (Skrj., 1916) Skrj., 1916 (=*Oxysoma dogieli* Skrj., 1916, =*Aplectana dogieli* (Skrj., 1916) Yorke & Maplestone, 1926). From intestine of a bufonid from Africa.

TABLE 10.—*Oxysomatium*

All measurements in millimeters	O. americana		O. baylisi		O. brevicaudatum		O. contortum		O. dogieli		O. hylambatis	
	male	female	male	female	male	female	male	female	male	female	male	female
Length	2.4	4.05	1.75	2.25	3–4.5	5–6	5.4	5.9	5.1	7.5	4–4.2	5.3–6
Width	0.15	0.27	0.1	0.175	0.2	0.28	0.3	0.35	0.2	0.29	0.26–0.3	0.3–0.37
Pharynx (length)	0.035	0.045	0.025	0.037	0.56	0.56	0.9	0.983	0.93	1.2	0.55	0.55
Esophagus (length)	0.315	0.34	0.35	0.4								
Bulb (length)	0.08×0.085	0.112×0.12	0.075	0.125	0.1	0.1	0.129	0.14	0.136	0.136	0.14×0.1	0.15×0.12
Head-exc. pore distance	0.35	0.39	0.365	0.35	Pre bulbar	Pre-bulbar	0.6	0.655	0.57	0.75	0.53	0.65
Head-nerve ring distance	0.15	0.27	0.1	0.197	?	?	?	?	0.51	0.66	0.3	0.33
Anus-tail distance	0.14	0.21	0.137	0.15	0.25	0.25	0.2	0.16	0.275–0.3	0.17	0.2	0.28–0.31
Spicule length	0.155		0.212		1.6–2		0.198		0.238		0.24–0.28	
Accessory piece length	0.072		0.075		0.127		0.11		0.085		0.09–0.1	
Papillae, number and position	5 pr. precloacal 1 pr. paracloacal 5 pr. postcloacal		3 pr. precloacal 1 pr. paracloacal 4 pr. postcloacal		9–10 pr. precloacal 3–4 pr. postcloacal		12 pr. precloacal 6 pr. postcloacal		6 pr. precloacal 5 pr. postcloacal		5 pr. precloacal 6 pr. postcloacal	
Vulva-anus distance		1.9		0.875		2.6		2.36		3.3		1.8
Egg sizes		?		0.1 × 0.45 (larvae)		0.08 × 0.1		0.07 × 0.039		?		0.1 × 0.55

TABLE 10 (Con. 1)—*Oxysomatium*

All measurements in millimeters	O. linstowi		O. longicaudata		O. longispiculum		O. machintoshii		O. membranosa	
	male	female	male	female	male	female	male	female	male	female
Length	4.3	5.2	2.88	3–4	3	5.5	2–2.47	2–6	2–2.6	2.4–3.5
Width	0.21	0.35	0.11	0.185	0.2	0.25	0.262	0.1–0.33	0.18	0.22
Pharynx (length) . . . Esophagus (length) .	0.566	0.633	0.37	0.397	1.0	1.0	0.025 / 0.25–0.3	0.025 / 0.34–0.44	0.044 / 0.36–0.41	0.056 / 0.38–0.4
Bulb (length)	0.113	0.126	0.058× 0.068	0.06× 0.075	Present	Present	0.06–0.07× 0.067	0.06–0.1× 0.06 0.125	0.12	0.28
Head-exc. pore distance	0.425	0.465	0.4	0.425	Pre-bulbar	Pre-bulbar	0.34–0.37	0.25–0.5	Pre-bulbar	Pre-bulbar
Head nerve ring distance	?	?	0.15	0.245	Pre-bulbar	Pre-bulbar	0.24–0.25	0.125–0.31	0.21	0.24
Anus-tail distance	0.2	0.423	0.233	0.45	0.3	0.3	0.26–0.3	0.35–0.5	?	0.2
Spicule length	0.22		0.15		0.3		0.24		0.22–0.23	
Accessory piece length.	?		0.036		Present		0.022		0.071–0.08	
Papillae, number and position	3 pr. precloacal		5 pr. precloacal 6 pr. postcloacal		10 pr. scattered		9 pr. precloacal 8 pr. postcloacal (lateral alae)	2 pr. postanal	2 pr. precloacal 2 pr. paracloacal 2–4 pr. postcloacal	
Vulva-anus distance		2.08		1.7–2		2.5		1–3		1.2–1.7
Egg sizes		0.091 × 0.052		?		0.09 × 0.11		0.05–0.22 × 0.075–0.33		0.056 × 0.096 (larvae)

TABLE 10 (Con. 2)—*Oxysomatium*

All measurements in millimeters	O. praeputiale		O. punctatum		O. ranae		O. tibetanum		O. sp. ?	
	male	female	male	female	male	female	male	female	male	female
Length	1.55–2.2	2.85–5.72	N	3.6	2.5	3.8	4.5–5	N	N	1.75
Width	0.2–0.3	0.21–0.435	o t	0.24	0.086	0.23	0.36–0.45	o t	o t	0.125
Pharynx (length)				0.045	0.035	0.03				
Esophagus (length)	0.31–0.37	0.42–0.69	K n	0.3	0.34	0.265	0.5 0.7	K n	K n	0.187
Bulb (length)	0.13–0.18	0.105–0.202	o w n	0.105 × 0.115	0.055 × 0.065	0.065 × 0.085	0.19–0.2 × 0.15–0.16	o w n	o w n	0.062
Head-exc. pore distance	0.2–0.33	0.3–0.39		0.28	0.36	0.28	0.65			0.162
Head-nerve ring distance	0.12–0.14	0.16		0.175	0.225	0.15	0.42			0.075
Anus-tail distance	0.22–0.25	0.24–0.495		0.45	0.225	0.23	0.17			0.162
Spicule length	0.22–0.27				0.16		0.58			
Accessory piece length	Absent				0.025		0.188			
Papillae, number and position	11 pr. post-cloacal. Cuticular papillae numerous	Cuticular papillae numerous			6 pr. pre-cloacal 2 pr. para-cloacal 2–3 pr. post-cloacal		22 pr. pre-cloacal 4 pr. post-cloacal			
Vulva-anus distance		1.4–2.86		2		2				0.75
Egg sizes		0.08 × 0.1337 (larvae)		0.062 × 0.105 (larvae)		0.056 × 0.076 (larvae)				0.0628 × 0.037 (morula)

f. *O. hylambatis* Baylis, 1927 (=*Aplectana hylambatis* (Baylis, 1927) Trav., 1931). From rectum of *Leptopelis aubryi*—Africa.

g. *O. linstowi* (Yorke & Maplestone, 1926) Baylis, 1927 (=*Nematoxys unguiculatus* v. Linst., 1906, =*Oxysomatium unguiculatum* (v. Linst., 1906) Skrj., 1916, =*Aplectana linstowi* Y. & M., 1926). From intestine of *Bufo viridis*—Europe (Corfu).

h. *O. longicaudata* (Walton, 1929) (=*Aplectana longicaudata* Walton, 1929). From intestine of *Rana pipiens*—U. S. A.

i. *O. longispiculum* Raill. & Henry, 1916 (=*Oxysoma brevicaudatum* (Zed., 1800) Schn., 1866, *ex. p.*). From intestine of *Rana temporaria*—Europe.

j. *O. macintoshii* (Stewart, 1914) Karve, 1927 (=*Oxysoma macintoshii* Stew., 1924, =*Oxysomoides macintoshii* (Stew., 1914) Walton, 1927, =*Aplectana macintoshii* (Stew., 1914) Trav., 1931). From rectum of *Bufo mauritanicus, B. viridis, Nectophrynoides vivipara,* and *Rana delalandii*—Africa; and *Bufo melanostictus, B. stomaticus* and *Rana tigerina*—India and Burma.

k. *O. membranosa* (Schn., 1866) (=*Leptodera membranosa* Schn., 1866, =*Aplectana membranosa* (Schn., 1866) Miranda, 1924). From large intestine of *Bufo crucifer, B. marinus, Leptodactylus ocellatus* and *Rana* sp.?—Brazil.

l. *O. praeputiale* (Skrj., 1916) (=*Oxyuris praeputialis* Skrj., 1916, =*Raillietnema praeputialis* (Skrj., 1916) Semenow, 1929). From intestine of *Bufo bufo* and *Rana esculenta*—Europe; and *Bufo regularis*—Africa.

m. *O. punctatum* Walton, 1932. From intestine of *Rana vittigera*—Phil. Is.

n. *O. ranae* Walton, 1931. From intestine of *Rana magna* and "Frogs"—Phil. Is.

o. *O. tibetanum* Baylis, 1927 (=*Aplectana tibetana* (Baylis, 1927) Trav., 1931). From rectum of *Scutiger alticolus*—Tibet.

p. *O.* sp.? (This paper). From intestine of *Rana limnocharis*—Java.

Through the courtesy of Dr. H. A. Baylis of the British Museum (Natural History) the following *Oxysomatium* material was placed at the disposal of the writer for description.

Oxysomatium baylisi n. sp. (Fig. 1).

The material from *Ceratophrys dorsata* consisted of both males and females, and seems to fall into the conception of the genus *Oxysomatium* (sensu Baylis).

Males:—Body length, 1.75 mm.; greatest width, 0.1 mm.; pharynx length, 0.025 mm.; esophagus length, 0.35 mm.; pyriform bulb length, 0.075 mm.; head-nerve ring distance, 0.1 mm.; head-excretory pore distance, 0.365 mm.; cloaca-tail distance, 0.1375 mm.; lateral alae, none; spicule length, 0.2125 mm.; accessory piece length, 0.075 mm.; caudal papillae, three pairs pre-cloacal, one pair paracloacal, and four pairs post-cloacal.

Females:—Body length, 2.25 mm.; width at vulva, 0.175 mm.; pharynx length, 0.0375 mm.; esophagus length, 0.4 mm.; pyriform bulb length, 0.125 mm.; head-nerve ring distance, 0.197 mm.; head-excretory pore distance, 0.35 mm.; anus-tail distance, 0.15 mm.; lateral alae, none; vulva-tail distance, 0.875 mm,; ovejector length, 0.05 mm.; eggs embryonated, 0.12 mm. by 0.045 mm.

This material was collected from the rectum of *Ceratophrys dorsata* (from Brazil) by Prof. O. Fuhrmann. It has been named *Oxysomatium baylisi* n. sp., in honor of Dr. H. A. Baylis of the British Museum (Natural History).

Type specimens in the collection of the British Museum (Natural History), No. 10.15.177–182.1929. From rectum of *Ceratophrys dorsata,* Brazil. 1929.

Oxysomatium macintoshii (Stewart, 1924) Karve, 1927.

The material from *Nectophrynoides vivipara* had earlier (Baylis, 1929) been referred to the species *Oxysomatium macintoshii* (Stewart, 1914) Karve, 1927, with some hesitancy because of the absence of male material. Careful examination of the specimens confirms the diagnosis.

Females:—Body length, 3–3.4 mm.; width at vulva, 0.25 mm.; pharynx length, 0.025 mm.; esophagus length, 0.3 mm.; head-nerve ring distance, 0.125 mm.; head-excretory pore distance, 0.25 mm.; anus-tail distance, 0.4–0.5 mm.; anal spike length, 0.33–0.42 mm.; vulva-tail distance, 1–1.6 mm.; eggs embryonated, 0.075 mm. by 0.5 mm.; lateral alae absent; ovaries prodelphous.

The specimens described are in the Collection of the British Museum (Natural History), No. 10.23.97–100.1929. Tanganyika Territory.

Oxysomatium sp.?

A species of *Oxysomatium* from Oriental amphibian hosts is represented by female specimens taken from the intestine of *Rana limnocharis* obtained in Java. No species designation is attempted on the basis of only female examples, but a description is appended as an indication of the occurrence of a species of the genus *Oxysomatium* in Java, a point perhaps of some ecological significance.

Female:—Body length, 1.75 mm.; width at vulva, 0.125 mm.; esophagus length, 0.1875 mm.; esophageal bulb length, 0.0625 mm.; head-nerve ring distance, 0.075 mm.; head-excretory pore distance, 0.1625 mm.; anus-tail distance, 0.1625 mm.; vulva-tail distance, 0.75 mm.; lateral alae, none; eggs segmenting, 0.0375 mm. by 0.0625 mm.; ovaries prodelphous.

This form approaches most nearly the females of *Oxysomatium macintoshii* (Stewart, 1914) Karve, 1927, but seems to vary in certain significant aspects. It may possibly be a geographic race of *O. macintoshii,* but the present information is not sufficient to settle the question definitely in either direction.

TABLE 11.—*Raillietnema*

All measurements in millimeters	R. loveridgei		R. simples	
	male	female	male	female
Length	1.88–1.98	2.2–2.4	1.7–1.75	2.4–2.6
Width	0.12	0.15	0.09	0.11–0.14
Esophagus (length)	0.34	0.34	0.4	0.5
Bulb (length)	0.08	0.08	0.052	0.072
Head-exc. pore distance	Pre-bulbar	Pre-bulbar	0.38	0.49
Head-nerve ring distance	0.12	0.12	0.2	0.25
Anus-tail distance	?	0.09	0.168	0.22–0.24
Spicule length	0.206–0.21		0.22	
Acc. piece length	0.029		0.016	
Alae	small, caudal		small?	
Papillae, number & position	1 pr. precloacal 2 pr. postcloacal		2 pr. precloacal 8 pr. postcloacal	
Vulva-tail distance		0.9–1.3		1.25
Egg sizes		0.076–0.078 × 0.14–0.16		0.22 × 0.12

Material described is in the Collections of the British Museum (Natural History), No. 10.25.123.1929, and labelled as coming from the intestine of *Rana limnocharis*, Java.

7. *Raillietnema* (Table 11).

a. *R. loveridgei* (Sandground, 1928) Trav., 1931 (=*Aplectana loveridgei* Sandground, 1928, =*Oxysomatium loveridgei* (Sandground, 1928) Baylis, 1929). From intestine of *Scolecomorphus vittatus*—Africa.

b. *R. simples* (Trav., 1925) Trav., 1927 (=*Oxysomatium simples* Trav., 1927). From large intestine and rectum of *Hyla faber*—Brazil.

Travassos established this genus for species of *Oxysomatium* showing simple amphidelphous ovaries in the females and having a gubernaculum in the males. These criteria justify the inclusion of *O. loveridgei* with *O. simples* in the genus and the exclusion of *O. praeputiale*. According to Semenow (1929), the last named species should be in *Raillietnema* in spite of the absence of a gubernaculum and the presence of a very complex ovarian coil.

VI. *Atractidae.*

1. *Atractis.*

a. *A.* sp.? (This paper). From intestine of *Bufo viridis*—Europe.

Members of this family have apparently not been recorded from Amphibia heretofore, and the description of material belonging here merits record. The specimens were made available for study by Dr. H. A. Baylis of the British Museum (Natural History).

Atractis sp.?

The material (Figs. 2, 3, 4) consisted of female specimens which show the characteristic mouth and pharyngeal structures of the genus, as well as the peculiarly chitinized excretory pore in the post-bulbar region, and the posteriorly placed vulva. The form is also apparently viviparous.

Female:—Body length, 3.85 mm.; width at vulva, 0.3 mm.; muscular esophagus length, 0.425 mm.; glandular esophagus length, 0.125 mm.; pyriform bulb length, 0.125 mm.; head-excretory pore distance, 0.65 mm.; head-nerve ring distance, 0.475 mm.; anus-vulva distance, 0.0375 mm.; anus-tail distance, 0.3 mm.; eggs, 0.035 mm. by 0.0625 mm.; contain coiled embryos. A few sheathed larvae free in uterus.

This form does not agree with the descriptions given for the females of identified species of *Atractis,* but no specific rank is here indicated in the absence of male material.

The specimens described are in the Collection of the British Museum (Natural History), No. 51.7.24.181, and were obtained from *Bufo variabilis* (=*B. viridis*).

VII. *Rhabdiasidae.*

Only one genus of this group is well represented among amphibian hosts.

TABLE 12.—*Rhabdias*

All measurements in millimeters	R. bdellophis	R. brachylaimus	R. bufonis	R. entomelas	R. escheri	R. fülleborni	R. incerta
Length	5.1–5.6	8.8	9–18	3.5	5 6	10 12	14.3
Width	0.35–0.42	0.48	0.5	0.3	0.25–0.26	0.47–0.48	0.4
Buccal Capsule (length)	Absent?	?	0.06 × 0.13	?	0.014 × 0.014	0.115	0.029 × 0.037
Teeth	None	None	None	?	None	None	?
Esophagus (length)	0.4–0.45	0.59–0.6	0.45–0.9	?	0.5–0.6	0.45–0.5	1.4
Vulva position	Equatorial	Equatorial	Post-equatorial	Equatorial	Post-equatorial	Pre-equatorial	Equatorial
Anus-tail distance	0.125–0.155	?	0.38 0.45	?	0.12	0.37–0.42	0.4
Egg size	0.125–0.137 × 0.05–0.065	0.12 × 0.065	0.112 × 0.048	?	?	0.125 × 0.08	0.094 × 0.049

TABLE 12 (Con.)—*Rhabdias*

	R. microoris	R. ranae	R. rotundata	R. rubrovenosa	R. sphaerocephala	R. tokyoensis	R. sp.?
Length	3.8–8.3	3.5–4.5	6	15	6–6.5	12	N
Width	0.17–0.35	0.3–0.4	0.31	0.4	0.3–0.35	0.52	o
Buccal Capsule (length)	0.008–0.012 × 0.006–0.008	Present	?	0.014 × 0.015	?	0.025 × 0.028	t D
Teeth	None	None	None	None	None	?	e
Esophagus (length)	0.34–0.38	0.45–0.55	0.33	?	0.43–0.45	0.66	s
Vulva position	Post-equatorial	Post-equatorial	Pre-equatorial	Pre-equatorial	Post-equatorial	Post-equatorial	c
Anus-tail distance	0.15–0.42	0.15–0.25	?	?	0.19–0.22	0.28	r
Egg sizes	0.044–0.06 × 0.101–0.118	0.04 × 0.075	0.097 × 0.057	0.13 × 0.053	?	0.11 × 0.05	i b e d

1. *Rhabdias* (Table 12).

a. *R. bdellophis* Baylis, 1929. From lungs of *Scolecomorphus vittatus*—Africa.

b. *R. brachylaimus* (v. Linst., 1903) Trav., 1930 (=*Angiostomum brachylaimus* v. Linst., 1903). From lungs of *Bufo melanostictus*.—Siam.

c. *R. bufonis* (Schrank, 1788) Stiles & Hassall, 1905 (=*Ascaris filiformis* Goeze, 1782, *ex. p.*, =*A. bufonis* Schrank, 1788 =*A. subulata* Schrank, 1788, *ex. p.*, =*A. dyspnoos* Gmel., 1790, =*A. insons* Gmel., 1790, =*A. pulmonalis* Gmel., 1790, =*A. trachealis* Gmel., 1790, =*A. nigrovenosa* Goeze, in Zed., 1800, =*A. bufonum* Rud., 1809, =*A. subulata bufonum* Rud., 1809, =*A. filiformis bufonum* Dies., 1851, =*Fusaria nigrovenosa* (Goeze, 1800) Zed., 1800, =*Rhabdonema nigrovenosum* (Goeze, 1800) Leuck., 1879, =*Angiostomum nigrovenosum* (Goeze, 1800) v. Linst., 1882). From lungs of *Bombina bombina, Bufo bufo, B. viridis, Pelobates fuscus, Rana esculenta, R. macrocnemis* and *R. temporaria*—Europe; from *Hyla arborea japonica, Rana japonica, R. nigromaculata,* and *R. rugosa*—Japan; from *R. ridibunda*—Turkestan; from *R. delalandii*—Africa; and from *Bufo americanus, Rana clamitans* and *R. palustris*—U. S. A.

d. *R. entomelas* (Leidy, 1851) Trav., 1930 (=*Ascaris entomelas* Leidy, 1851). From lungs of *Rana palustris* and *R. sphenocephala*—U. S. A.

e. *R. escheri* Baer, 1930. From lungs and body cavity of *Uraeotyphlus oxyurus*—India.

f. *R. fülleborni* Trav., 1926. From lungs of *Bufo marinus*—Brazil.

g. *R. incerta* Wilkie, 1930. From lungs of *Rana japonica*—Japan.

h. *R. microoris* Semenow, 1929. From lungs of *Bufo bufo, B. viridis,* and *Rana temporaria*—European Russia.

i. *R. ranae* Walton, 1929 (=*R. entomelas* (Leidy, 1851) Trav., 1930, *ex. p.*). From lungs of *Acris gryllus, R. palustris, R. pipiens, R. sphenocephala* and "Frogs"—U. S. A.

j. *R. rotundata* (v. Linst., 1906) Trav., 1930 (=*Angiostomum rotundatum* v. Linst., 1906). From lungs of *Bufo viridis*—Europe (Corfu).

k. *R. rubrovenosa* (Schn., 1866) Trav., 1930 (=*Leptodera rubrovenosa* Schn., 1866, =*Rhabditis rubrovenosa* (Schn., 1866) Oerley, 1880, =*Angiostomum rubrovenosum* (Schn., 1866) v. Linst., 1885). From lungs of *Bufo bufo, B. viridis, Pelobates fuscus* and *Rana temporaria*—Europe.

l. *R. sphaerocephala* Goodey, 1924. From lungs of *Bufo bufo*—Europe.

m. *R. tokyoensis* Wilkie, 1930. From lungs of *Triturus pyrrhogaster*—Japan.

n. *R.* sp.? (Johnston, 1916) (=*Rhabdonema* sp.? Johnston, 1916). From lungs of *Hyla coerulea*—Australia.

2. *Strongyloides.*

a. *S. stercoralis* (Bavay, 1876) Stiles & Hassall, 1902. From intestine of *Rana esculenta*—Italy.

This parasite is undoubtedly of accidental occurrence in Amphibia as it is normally a parasite of mammals, particularly of primates.

VIII. Anguillulinidae.

Sub-family uncertain.

1. *Myoryctes.*

   a. *M. weismanni* Eberth, 1863. From muscle cysts in *Rana temporaria*—Europe. Length: Males, 0.162–0.216 mm.; females, 0.6497 mm. Width, Males, 0.0135–0.0162 mm.; females, 0.02 mm. Anus-tail distance: Males, (1/9) 0.018–0.024 mm.; females, (1/9) 0.0722 mm. Vulva in posterior third of body. Spicules equal and short.

2. *"Anguillula" s.l.*

   a. *A. ranae-temporariae* Perty, 1852. A larval form found in *Rana temporaria* in Switzerland, is undescribed, but probably should be listed as *"Agamonema"* instead of *"Anguillula."*

Host List

The list of the host names presented above, as well as their synonyms as used by various investigators, is as follows:

Rana areolata Baird & Gir., 1852.

R. catesbiana Shaw, 1802 (=*R. catesbeiana* (Shaw, 1802) Cope, 1889. =*R. mugiens* Merr., 1820).

R. clamitans Latr., 1802.

R. delalandii (Tsch., 1838) Blgr., 1882 (=*Pyxicephalus delalandii* Tsch., 1838).

R. esculenta L., 1758 (=*Pelophylax esculenta* (L., 1758) Fitz., 1843, =*Bufo esculenta* of Skrjabin, 1916).

R. esculenta-japonica Blgr., 1882.

R. limnocharis Boie, 1835.

R. macrocnemis Blgr., 1885.

R. magna Stejneger, 1909.

R. nigromaculata Hallowell, 1860.

R. nutti Blgr., 1896.

R. palustris Le Conte, 1825.

R. pipiens Schreber, 1782 (=*R. halecina* Kalm, 1766, *ex. p.*).

R. ridibunda Pallas, 1771.

R. rugosa Schleg., 1838.

R. sphenocephala (Cope, 1886) Stejneger & Barbour, 1917.

R. sylvatica Le Conte, 1825.

R. temporaria L., 1758 (=*R. alpina* Risso).

R. tigerina Daud., 1803 (=*R. tigrina* of aucts.).

Leptopelis aubryi (Dum., 1856) Günth., 1858 (=*Hylambates aubryi* (Dum., 1856) Dum., 1861.

Probreviceps macrodactylus (Nieden., 1826) Parker, 1931 (=*Breviceps macrodactylus* Nieden., 1826).

Leptodactylus ocellatus L., 1758 (=*Cystignathus pachypus* Spix, 1824).

L. pentadactylus Laur., 1768 (=*Cystignathus gigas* Spix, 1824).

L. typhonius Daud., 1803 (=*L. sibilatrix* Fitz., 1843).

Eleutherodactylus binotatus (Spix, 1824) Ptrs., 1863 (=*Hylodes binotatus* Spix, 1824).

E. gollmari Ptrs., 1863 (=*Hylodes güntheri* Steindachn., 1848).

E. miliaris (Spix, 1824) Ptrs., 1863 (=*Hylodes miliaris* (Spix, 1824) Ptrs., 1861).

Elosia nasus Lichtenst., 1823.

Ceratophrys cornuta (L., 1758) Wied., 1825 (=*Rana cornuta* L., 1758).

C. dorsata Wied., 1835 (=*C. varia* Cuvier, 1829, *ex. p.*).

Bufo americanus Holbrook, 1836 (=*Rana musica* L., 1758, =*Bufo lentiginosus* Shaw, 1802, *ex. p.* = *B. musica* (L., 1758) Tsch., 1838).

B. bufo L., 1758 (=*B. vulgaris* Laur., 1768 =*B. cinereus* Schn., 1799 =*Phryne vulgaris* (Laur., 1768) Fitz., 1843).

B. crucifer Wied., 1821 (=*B. ornatus* Spix, 1824. *Otilophus cinctus* Wied., 1835).

B. marinus L., 1758 (=*B. agua* Latr., 1802 =*Docidophryne agua* (Latr., 1802) Fitz., 1843).

B. mauritanicus Schleg., 1841.

B. melanostictus Schn., 1799.

B. regularis Reuss., 1833.

B. stomaticus Lütken, 1863.

B. valliceps Wiegmann, 1833.

B. viridis Laur., 1768 (=*Rana variabilis* Pallas, 1769 =*Bufo variabilis* (Pallas, 1769) Merr., 1820).

Nectophrynoides vivipara Tornier, 1905.

Acris gryllus (Le Conte, 1825) Dum. & Bibr., 1841.

Pseudacris triseriata (Wied., 1838) Stejneger & Barbour, 1917.

Hyla arborea L., 1758 (=*Dendrohyas viridis* Laur., 1768).

H. arborea japonica Günth., 1858.

H. caerulea White, 1790.

H. cinerea (Schn., 1799) Garman, 1892 (=*H. carolinensis* Cope, 1889).

H. crepitans Wied., 1824 (=*H. pardalis* Spix, 1824).

H. gracilenta Ptrs., 1869.

H. faber Wied., 1821 (=*Hypsiboas faber* (Wied., 1821) Wagl., 1824).

H. langsdorfi Dum. & Bibr., 1841.

H. luteus (Fitz.)? (=*Calamites luteus* Fitz.) (*nomen nudum*?).

H. mesophaea Hensel, 1867.

H. microps Ptrs., 1872.

H. squirella Latr., 1802.

H. tschudii (Fitz.)? (=*Phrynohyas tschudii* Fitz.) (*nomen nudum*?).

Pelobates fuscus (Laur., 1768) Laur., 1768 (=*Bufo fuscus* Laur., 1768).

Scutiger alticolus (Procter, 1922) Procter, 1922 (=*Cophophryne alticola* Procter, 1922).

Scaphiopus couchii Baird, 1854.

Bombina bombina (L., 1758) L., 1758 (=*Rana bombina* L., 1758, =*Bombinator igneus* (Laur., 1768) Merr., 1820, =*Bombinator salsa* Schrank, 1785).

Salamandra atra Laur., 1768.

S. salamandra L., 1758 (=*S. maculosa* Laur., 1768=*S. maculata* Merr., 1820).

Triturus alpestris (Laur., 1768) Raf., 1815 (=*Triton alpestris* Laur., 1768. =*Triton igneus* Bechst., 1802).

T. cristatus (Laur., 1768) Raf., 1815 (=*Triton cristatus* Laur., 1768=*Salamandra lacustris* Gmel., 1789).

T. meridionalis (Cope, 1880) Dunn, 1918.

T. pyrrhogaster Boie, 1826.

T. viridescens Raf., 1820 (=*Diemyctylus viridescens* (Raf., 1820) Cope, 1889).

T. vulgaris (L., 1758) Raf., 1815 (=*Triton vulgaris* L., 1758=*Molge vulgaris* (L., 1758) Blgr., 1882a=*Triton teniatus* Leydig, 1867=*T. punctatus* Bonap., 1838 =*Lissotriton punctatus* (Bonap.) Bell., 1839=*Triton exiguus* Laur., 1768).

Tylototriton andersoni Blgr., 1892 (= *Tylotriton andersoni* of aucts.).

Ambystoma texanum Matthes, 1855 (=*Amblystoma microstomum* Cope, 1861 =*Ambystoma microstomum* (Cope, 1861) Stejneger & Barbour, 1917).

A. tigrinum (Green, 1825) Baird, 1849 (=*Amblystoma tigrinum* (Green, 1825) Cope, 1889=*Siredon mexicanus* Baird, 1850, =*Axolotl,* of aucts.).

Hynobius fuscus Tago, 1907.

H. kimurae Dunn, 1923.

H. stejnegeri Dunn, 1923.

Onychodactylus japonicus Houttuyn, 1782.

Pseudotriton ruber (Sonnini, 1802) Dunn, 1920 (=*Salamandra rubra* Sonnini, 1802. =*Spelerpes ruber* (Sonnini, 1802) Cope, 1889).

Amphiuma means Garden, 1821.

A. tridactylum Cuvier, 1827.

Cryptobranchus alleganiensis (Daudin, 1803) Stejneger & Barbour, 1917 (=*C. alleghaniensis* Van der Hoeven, 1837=*C. allegheniensis* Cope, 1889).

Uraeotyphlus oxyurus Dum. & Bibr., 1841.

Siphonops annulatus Mikan, 1820.

Scolecomorphus vittatus (Blgr., 1895) Barbour & Loveridge, 1928 (=*Bdellophis vittatus* Blgr., 1895).

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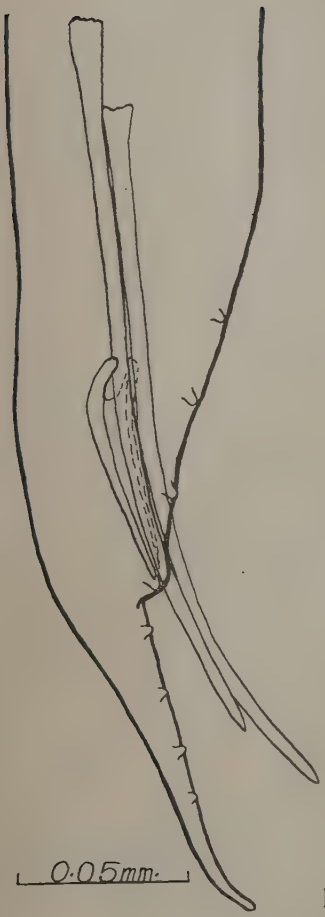
Explanation of Figures

Figure 1. *Oxysomatium baylisi.* Tail of male, lateral view.
Figure 2. *Atractis* sp.? Anterior end of female, lateral view.
Figure 3. *Atractis* sp.? Anterior end of female, dorsal view.
Figure 4. *Atractis* sp.? Posterior end of female, lateral view.

PLATE I



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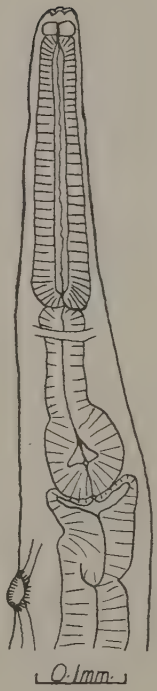

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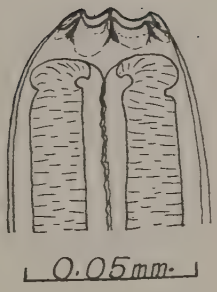

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4

THE CULTURE OF *PARAMECIUM CAUDATUM* FREE FROM LIVING MICROORGANISMS*

R. W. Glaser and N. A. Coria

In a previous publication (1) we reported methods for freeing protozoa from associated bacteria and cultivating them on artificial media. We stated that, while we were able to free *Paramecium caudatum* from living microorganisms, we were unable to propagate it in this condition. We could, however, establish growth when we associated with it a pure culture of certain bacteria or a yeast. Since Paramecia have been used so extensively for physiological, toxicological, and other biological work, it seemed important to continue our experiments in the attempt to secure a medium in which the purified protozoa would grow.

In the present paper we report the development of such a technique. An experiment to determine when the Paramecia can be freed from contaminating organisms follows:

Paramecium caudatum associated with living yeast was grown in potato water or in our so-called "basic medium" (1) with fresh rabbit kidney. The Paramecia were then centrifuged and washed three times in sterile tap water, transferred to the bases of the long pipettes described in the previous paper, and allowed to migrate by negative geotropic action through the column of sterile tap water. The results of cultures made daily from the surface are given in Table 1.

Here it is shown that on and after the 2nd day the Paramecia had either washed themselves free from the associated yeasts or had digested them, so that no growth was obtained on dextrose agar slants. About the 4th day migration was complete, *i.e.*, the Paramecia were all at the surface. Examination of the tubes showed that the protozoa lived in the pipette for approximately 7 days.

MEDIUM USED

After trying various combinations of substances, a medium consisting of liver extract, killed yeast, and fresh rabbit kidney was found to be satisfactory for the growth of these sterile Paramecia. This medium was prepared as follows:

Liver Extract.—To 100 cc. of sterile tap water we added ½ gm. of Eli Lilly Company's liver extract No. 343. After filtering through paper the solution was passed through a sterile Berkefeld "N" filter and distributed in 10 cc. amounts into sterile test-tubes. The filtered extract had a reaction of pH 6.2–6.4. It was tested for sterility on the usual bacteriological media.

* From the Rockefeller Institute for Medical Research, Department of Animal and Plant Pathology, Princeton, New Jersey.

TABLE I.—*Results Obtained from Migration Pipette Held Vertically for 5 Days at Temperature 20–22° C.*

Time in days	1	1	2	2	3	3	4	4	5	5
Extent of migration	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete	Complete	Complete	Complete	Complete
Sterility tests	Isolated yeast colonies in 48 hrs.	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile

Instead of the commercial liver extract the following may be used:

To 100 gm. of finely ground rabbit, beef, or swine liver was added 200 cc. of sterile tap water. This suspension was infused overnight in the refrigerator, filtered through cotton, and heated over a water bath for approximately 1 hour or until no more coagulation occurred. The supernatant liquid was strained through fine gauze and all the excess fluid pressed out of the coagulum. This liquid was centrifuged and brought to 400 cc. with tap water. It was then warmed to about 60° C., passed through sterile Berkefeld candles, grade "V" followed by grade "N," and distributed in 10 or 20 cc. amounts into sterile test-tubes. Tests for sterility were made on the usual culture media. The reaction of the rabbit liver extract was pH 6.4–6.6, while the beef and swine extracts had a reaction of pH 6.8–6.9.

Sterilization of the liver extract by heating, either by autoclaving or in the Arnold sterilizer, did not give a satisfactory medium.

Dead Yeast.—Bakers' yeast was grown for 5 days on dextrose agar in a Blake bottle. The growth was washed off with sterile tap water and the yeast thrown to the bottom of a centrifuge tube. The sediment was suspended in clean water and the organisms again sedimented. The washed yeasts were suspended in 15 cc. of sterile tap water and the suspension transferred to tubes, 5 cc. to each. These tubes were sealed and immersed in a water bath at a temperature of 75–80° C. After being so heated for 30 minutes transfers were made to dextrose agar slants to test for sterility.

Instead of the killed yeast, killed cultures of *Staphylococcus pyogenes aureus* or *albus* may be used.

Final Preparation and Inoculation of the Medium.—Using sterile instruments and aseptic precautions, pieces of kidney weighing 2 or 3 gm. were transferred from a freshly killed rabbit to tubes of liver extract. To each tube was then added 0.1 cc. of the heat-killed yeast suspension and Paramecia from the surface of the migration pipette. In the procedure we used, the inoculum contained approximately 870 bacteria-free Paramecia. On the 2nd and 4th days of incubation a further 0.1 cc. of the dead yeast was added to each tube.

When these inoculated tubes were incubated at room temperature growth of the Paramecia was well established on the 7th or 8th day and luxuriant by the 10th day. Successful transplantations of the Paramecia have been obtained between the 7th and 15th day of incubation, and in some cases have been successful after 6 weeks. The temperature of incubation must be considered; growth occurs between 20° and 28° C., with the optimum at 25° C. At 30° C. the Paramecia are killed.

TABLE 2.—*Effect of Liver Extract, Kidney and Yeast on the Growth of Paramecium.*

Medium	Test No.	Degree of growth in days					Transplant
		2	4	6	8	10	
Water + kidney***	1	±***	+	+	+	−	Negative
" "	2	±	+	+	+	−	"
" "	3	±	+	+	+	−	"
Water + kidney + dead yeast	4	±	+	+	+	−	"
" " " "	5	±	+	+	+	−	"
" " " "	6	±	+	+	+	−	"
Water + kidney + living yeast	7	+	++	+++	++++	++++	Positive
" " " "	8	+	++	+++	++++	++++	"
" " " "	9	+	++	+++	++++	++++	"
Lilly's extract + kidney + dead yeast	10	+	++	+++	++++	++++	"
" " " " "	11	+	++	+++	++++	++++	"
" " " " "	12	+	++	+++	++++	++++	"
" " "	13	+	+	+	+	+	Negative
" " "	14	+	+	+	+	+	"
" " "	15	+	+	+	+	+	"
Lilly's extract + dead yeast	16	+	+	+	+	+	"
" " " "	17	+	+	+	+	+	"
" " " "	18	+	+	+	+	+	"
Liver extract + kidney + dead yeast	19	+	++	+++	++++	++++	Positive
" " " " "	20	+	++	+++	++++	++++	"
" " " " "	21	+	++	+++	++++	++++	"

*** Water = sterile tap water; kidney = fresh rabbit kidney; Lilly's extract = extract prepared from Eli Lilly and Company's liver extract No. 343; liver = rabbit liver extract prepared in this laboratory; − = dead; ± = doubtful growth; + = weak growth; + + = fair growth; + + + = good growth; + + + + = luxuriant growth.

That the liver extract, killed yeast, and fresh kidney are essential for the growth of the bacteria-free Paramecia is shown in Table 2. It is seen that if any one of these substances is omitted, growth is questionable or at best poor, and that transfers are not successful. If living yeasts are present, growth will occur in sterile water containing kidney and on a variety of other media.

TESTS FOR BACTERIAL STERILITY

As a routine, subcultures from the Paramecium cultures were made at the time of transfer into broth, milk, deep agar, and gelatin, and onto the surface of blood and dextrose agar slants. As an additional test for anaerobic bacteria, transfers were occasionally made to the deep column of dextrose bouillon under vaseline. In addition, cultures were centrifuged and the sediment, after staining, examined microscopically for organisms. In such stained preparations one may at first be confused by the superficial resemblance between cilia torn from the Paramecia and bacteria.

RESULTS

Using a Lilly liver extract medium plus killed yeast and rabbit kidney, a strain of bacteria-free *Paramecium caudatum* has been carried through 22 subcultures over a period of 6 months. In fresh liver extract plus these same substances, this same strain has been grown for 12 transfers over a period of 3 months. We have been unable to demonstrate bacteria or yeasts in these cultures either by transfers made to the media noted above or by microscopical examinations.

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ON IMMUNITY REACTIONS OF SNAILS TO THE PENETRATION OF THE CERCARIAE OF THE STRIGEID TREMATODE, *COTYLURUS FLABELLIFORMIS* (FAUST)[1]

L. O. Nolf and W. W. Cort

The fact that in the life cycle of the strigeid of the duck, *Cotylurus flabelliformis,* the same species of snails serve both as intermediate and second intermediate hosts has made possible the study of the relation of previous infestation of these snails with larval trematodes to the penetration of the cercariae and the development of the metacercariae of this species. Since *C. flabelliformis* is a common paratype of the duck in the region where the University of Michigan Biological Station is located it was possible to obtain material for this study in the summer of 1932.

The life cycle of *C. flabelliformis* has been worked out in its various stages by a group of workers in the last sixteen years (Faust, 1917; Cort, 1917; Cort and Brooks, 1928; Hughes, 1929; Van Haitsma, 1931). The sporocysts of this species develop in *Lymnaea stagnalis appressa* Say, *L. stagnalis perampla* Walker and *Stagnicola* (*Lymnaea*) *emarginata angulata* (Sowerby). Cercariae begin to escape from these snails about six weeks after the penetration of the miracidia. These cercariae then penetrate into these same species of snails and also into a smaller form *Fossaria obrussa* Say and develop in a period of about six weeks going through a very great metamorphosis into mature encysted metacercariae of the tetracotyle type. When snails containing these fully developed tetracotylids are eaten by ducks the adults of *C. flabelliformis* are able to develop to sexual maturity in about four to six days.

Winfield (1932) has recently shown that individuals of *L. stagnalis appressa* and *L. stagnalis perampla* which were infested with the sporocysts of *C. flabelliformis* were highly resistant to the penetration of its cercariae, although these two snails varieties serve very effectively both naturally and experimentally as the second intermediate host of this species. He suggested that this immunity plays an important part in the survival of snails harboring the sporocyst stages of this trematode since it prevents them from being overwhelmed by the repenetration of the large numbers of cercariae which escape. The results reported in this paper confirm Winfield's work and extend the studies to include

[1] A joint contribution from the University of Michigan Biological Station, the Department of Zoology of the University of Iowa, and from the Department of Helminthology of the School of Hygiene and Public Health of the Johns Hopkins University.

the effect on the penetration of the cercariae of this species of the presence in normal second intermediate hosts of other species of larval trematodes.

We will first consider the relation of infestation with the sporocysts of *C. flabelliformis* in *L. stagnalis perampla* and *L. stagnalis appressa*[2] to the penetration of the cercariae of this species. Three experiments were carried out to test this point. To obtain the positive snails collections were made from an area on the shore of the lake where infestations with *C. flabelliformis* were known to occur. The snails brought into the laboratory were isolated in half pint milk bottles. The water in these bottles was examined at intervals and those snails giving off cercariae were separated, and the species of the cercariae determined. In this way a group of snails known to be infested with the sporocysts of *C. flabelliformis* was obtained. The negative snails for controls were obtained from another lake where *C. flabelliformis* had never been found. These were also isolated in milk bottles and snails from which any type of cercariae were escaping were discarded. Some of this group were examined in each case and found to be uniformly free from all stages of *C. flabelliformis.* A final check on the control group was also made at the time of autopsy since any immature infestations present were found then.

The three experiments given in Table 1 were carried out at different times as positive snails became available. In setting up an experiment the individual snails both of the positive and negative groups were marked and placed in separate bottles with corresponding labels. The water in the bottles was changed at least once a day and the snails were fed with lettuce. The few snails that died in the course of the experiment are not included in the records. To expose the snails to the penetration of the cercariae both the infested snails and the controls were taken from their bottles and placed all together in shallow water in an evaporation dish. Large numbers of cercariae of *C. flabelliformis* obtained from a number of different infested snails were then placed in the water with the snails. The exposure was continued from three to five hours. In this way the positive and negative snails were given the same exposure to cercariae since they were in the same dish during this period. In the first two experiments (Table 1, A and B) the cercariae of *C. flabelliformis* to which the snails were exposed came from positive specimens of *L. stagnalis appressa* and *L. stagnalis perampla* while in the third experiment (Table 1, C) they were from *Stagnicola emarginata angulata.* After the period of exposure in each experiment the snails were replaced in their proper bottles and kept separated until the

[2] These two varieties of snails are difficult to distinguish and are intermingled in this area. Both were used in all the experiments without any attempt being made to determine to which variety each individual belonged.

TABLE 1.—*Showing the number of developing metacercariae obtained from autopsy of groups of snails,* Lymnaea stagnalis perampla *and* L. stagnalis appressa *infested with the sporocysts of* C. flabelliformis *eight days after exposure to cercariae of the same species as compared with the number obtained from uninfested controls given the same exposure. The cercariae of* C. flabelliformis *used in Experiments A and B were from* L. stagnalis appressa *and* L. stagnalis perampla, *while in Experiment C they were from* Stagnicola emarginata angulata.

Group. I. Results from snails infested with the sporocysts of *Cotylurus flabelliformis*		Group II. Uninfested controls	
Snail number	Metacercaria count	Snail number	Metacercaria count
	Experiment A		
1	0	1	336*
2	2	2	459
3	8	3	1,084
4	12	4	1,052
5	23	5	1,425
6	33		
7	52		
8	67		
9	97		
	Experiment B		
1	2	1	1,290
2	8	2	1,659
3	12	3	2,036
4	14	4	2,990
5	16	5	3,701
6	18	6	3,997
7	20	7	4,056
8	29	8	4,247
9	32	9	4,518
10	34	10	4,776
11	36	11	5,296
12	46	12	6,478
13	67		
14	155		
15	1,058		
	Experiment C		
1	5	1	402
2	5	2	649
3	6	3	900
4	11	4	959
5	18	5	1,021
6	26	6	1,048
6	26	7	1,080
8	35	8	1,099
9	92	9	1,139
10	108	10	1,311

* This snail when autopsied was found to have developing schistosome sporocysts.

time for autopsy. It should be kept in mind that during the whole period of the experiment the positive snails were exposed to the large numbers of cercariae of *C. flabelliformis* which escaped each day from their own infestations.

Eight days after the exposure to the cercariae the snails were autopsied and the developing metacercariae stages of *C. flabelliformis* that were present were counted. Since the metacercariae stages of this species develop in the "liver" of the snail this part was isolated, carefully teased apart and the counts made in a ruled dish under a binocular microscope. This method of examination is tedious and since it is almost impossible to tease apart every single shred of liver tissue some of the metacercariae were probably missed. The same method of examination was used for each snail so that any errors in counting applied equally to all groups and individuals. By eight days when the examinations were made the metacercariae which developed from the cercariae

that had penetrated at the time of exposure had increased to two to three times the length of the body of the cercaria. By this time they are highly vacuolated and very active. They are, therefore, easily distinguishable from the bodies of the cercariae which were present in large numbers in the infested group. After eight days' development they also cannot be confused with the fully developed metacercariae of *C. flabelliformis,* which were present in varying numbers in most of the infested group, since these are much larger, are encysted and show the characters of a tetracotyle. These fully developed tetracotylids were present in almost all the snails from the area where *C. flabelliformis* was found, and in the positive snails probably had developed before the infestation with the sporocysts of this species had been acquired.

The results of the examinations in the three experiments of this series are given in Table 1. The numbers of developing metacercariae of *C. flabelliformis* present in the negative control groups vary in the three different experiments according to the numbers of cercariae used. The variations within a single negative group are probably produced by differences in activity of the different individual snails during the period of exposure. All three experiments, however, show comparable differences between the average numbers of metacercariae in the negative control groups and in those infested with the sporocysts of *C. flabelliformis.* The differences between these groups as shown in Table 1 are very striking and highly significant statistically, and are attributed to an immunity produced by the development and presence of the larval stages of this species in the positive groups.

These results added to those obtained by Winfield clearly demonstrate that those individuals of *L. stagnalis appressa* and *L. stagnalis perampla* which harbor infestations with the sporocysts of *C. flabelliformis* have a high degree of immunity to the penetration of the cercariae of this species, which penetrate and develop in large numbers in uninfested individuals of these snail varieties. It is seen that this immunity is not absolute since all the infested snails except one harbored at the time of autopsy varying numbers of the developing metacercariae. It is interesting also that one of the 34 snails in the three infested groups (No. 15, Experiment B) showed little if any immunity since it harbored 1,058 developing metacercariae. Such exceptions are hard to explain but are very commonly found wherever immunity phenomena are studied. Another point that should be noted in these experiments is that the results are the same in Experiment C, where the cercariae of *C. flabelliformis* to which the snails were exposed came from infested individuals of *Stagnicola emarginata angulata,* as they were in Experiments A and B in which the cercariae came from *L. stagnalis appressa* and *L. stagnalis perampla.*

In addition we were able to confirm Winfield's observations that the immunity in the infested snails produces changes which prevent the penetration of the cercariae. Repeated direct observations showed that when the cercariae came in contact with the body surfaces of the infested snails they reacted entirely differently than did those that came in contact with the uninfested snails. With the uninfested snails the cercariae in large numbers started to penetrate as soon as they came in contact with an exposed surface. They soon lost their tails and their bodies quickly disappeared into the tissue. In the case of snails infested with the sporocysts of *C. flabelliformis* the cercariae of this species after coming in contact with an exposed surface would move along with a looping movement and soon swim away. Their reaction appeared in these cases to resemble that commonly exhibited by strigeid cercariae when they come in contact with an abnormal host.

The findings recorded above made it seem of interest to carry out further experiments to see if the presence of infestations with larval trematodes of other species produces a non-specific immunity to the penetration of the cercariae of *C. flabelliformis* into snails which normally serve as the second intermediate hosts for this species. In the first of these experiments small snails of the species *Fossaria obrussa* Say were used. The cercariae of *C. flabelliformis* penetrate actively into this snail and the metacercariae appear to develop normally. The experiment with this species of snail recorded in Table 2 was carried out in the same way as the one just discussed, except that the uninfested and infested snails were kept in separate dishes during exposure to cercariae, since they were so small that it was difficult to mark them individually. Also several of the infested snails were exposed with the uninfested controls since the presence of their infestations were only determined at autopsy. An examination of the counts in Table 2 shows that while there is a considerable variation in the numbers of developing metacercariae found in the different individuals, there are no significant differences between the mean of the counts for the uninfested controls and those of any of the infested groups. Two of these infestations (Group 1 and 3) were with the larval stages of stigeids and the other (Group 2) with a stylet cercaria the adult of which probably belongs to the family Plagiorchidae. It is perhaps especially significant that no non-specific immunity to the penetration of the cercariae of *C. flabelliformis* was shown in snails infested with the larval stages of species belonging to the same family.

In the second experiment (table 3) on non-specific immunity snails of the species *Stagnicola* (*Lymnaea*) *emarginata angulata* (Sowerby) were used. This experiment was carried out in exactly the same way as those previously discussed with the infested and uninfested snails

TABLE 2.—*Showing the number of developing metacercariae obtained from autopsy of groups of snails,* Fossaria obrussa *infested with three different species of larval trematodes seven days after exposure to the cercariae of* Cotylurus flabelliformis *as compared with those found in uninfested controls given the same exposure.*

Group I. Infested with sporocysts of *Cercaria modicella* Cort and Brooks		Group II. Infested with sporocysts of *Cercaria polyadena* Cort		Group III. Infested with sporocysts of undescribed holostome cercariae (Holostome E)		Group IV. Uninfested controls	
Snail number	Metacercaria count	Snail number	Metacercaria count	Snail number	Metacercaria count	Snail number	Metacercaria count
1	1	1	0	1	9	1	5
2	2	2	0	2	32	2	9
3	6	3	0	3	37	3	18
4	7	4	3	4	39	4	25
5	8	5	8	5	41	5	36
6	19	6	8	6	45	6	39
7	21	7	9			7	46
8	25	8	10			8	127
9	27	9	17				
10	27	10	18				
11	29	11	42				
12	39	12	42				
13	44	13	43				
14	51	14	64				
15	54						

marked and exposed to the cercariae of *C. flabelliformis* in the same dish. For some unexplained reason in this case the snails infested with the sporocysts of *Cotylurus communis,* took heavier infestations than the negatives, although the difference between the means of the two groups is not statistically significant. Certainly there is not the slightest indication in this experiment of an immunity to the penetration of the cercariae of *C. flabelliformis* in the snails infested with the larval stages of *Cotylurus communis,* a species of the same genus.

TABLE 3.—*Showing the number of developing metacercariae obtained from autopsy of groups of snails,* Stagnicola emarginata angulata (*Sowerby*) *infested with the sporocysts of* Cotylurus communis (*Hughes*) *six days after exposure to the cercariae of* Cotylurus flabelliformis *as compared with those obtained from uninfested controls given the same exposure.*

Group 1. Results from snails infested with sporocysts of *Cotylurus communis*		Group 2. Results from uninfested controls	
Snail number	Metacercaria count	Snail number	Metacercaria count
1	97	1	0
2	106	2	25
3	129	3	40
4	144	4	51
5	148	5	59
6	167	6	72
7	224	7	121
8	306		

Finally two experiments were carried out to determine whether the presence of the sporocysts of a schistosome (*Schistosomatium douthitti* (Cort)) produced any immunity in *L. stagnalis appressa* and *L. stagnalis perampla* to the penetration of the cercariae of *C. flabelliformis.* The snails used in this experiment were obtained from a lake at some distance from Douglas Lake and showed no infestation with any stages of *C. flabelliformis.* In this case the cercariae for penetration were all obtained from *L. stagnalis appressa* and *L. stagnalis perampla.* These experiments were carried out in exactly the same way as has already been described for the first series.

The data from the counts are given in Table 4 A and B and demonstrate a partial non-specific immunity to the penetration of *C. flabelliformis* in the snails of these varieties infested with the sporocysts of *Schistosomatium douthitti.* While the immunity shown in these experiments is not as striking as in the first series of experiments in the snails infested with the sporocysts of *C. flabelliformis* it is clearcut and the differences between the means of the numbers of developing metacercariae obtained from the infested and uninfested groups are in

TABLE 4.—*Showing the number of developing metacercaria obtained from autopsy of groups of snails,* Lymnaea stagnalis perampla *and* L. stagnalis appressa *infested with the sporocysts of* Schistosomatium douthitti (*Cort*) *as compared with those obtained from uninfested controls given the same exposure to cercariae of* C. flabelliformis.

Group 1. Results from snails infested with the sporocysts of *Schistosomatium douthitti*		Group 2. Results from uninfested controls	
Snail number	Metacercaria count	Snail number	Metacercaria count
	Experiment A		
1	4	1	84
2	10	2	118
3	20	3	121
4	57	4	173
5	58	5	182
6	76	6	202
7	82	7	301
8	174		
	Experiment B		
1	6	1	407
2	40	2	483
3	63	3	552
4	67	4	554
5	72	5	590
6	85	6	602
7	86	7	652
8	90	8	654
9	183	9	682
10	202	10	974
11	312	11	1,090
12	349	12	1,165
13	381	13	1,198
14	455	14	1,205
15	830	15	1,264
16	891	16	1,342
		17	1,475
		18	1,648
		19	2,024
		20	2,806

both cases clearly significant statistically. It was noticed when these examinations were made that the developing metacercariae of *C. flabelliformis* appeared to be smaller in the snails infested with the larval schistosomes than in the uninfested snails. In fact measurements of the lengths of these developing metacercariae from four infested snails as compared with a series from five uninfested ones showed a very distinct and significant difference (Table 5). It is, therefore, clear that the presence of the sporocyst stages of *Schistosomatium douthitti* in these snails not only reduced the numbers of metacercariae of *C. flabelliformis* as compared with uninfested snails with the same exposure to cercariae but retarded the growth of those that did develop. It is not clear why the presence of schistosomes should produce this non-specific immunity when it was not present in the other snails infested with strigeid cercariae. It may be significant that this was the only experiment in which non-specific immunity was tested in *L. stagnalis appressa* and *L. stagnalis perampla.* It is possible that these snails are more suitable material for the production of a non-specific immunity than are those used in the other experiments of this type

TABLE 5.—*Showing average length of developing metacercariae of* Cotylurus flabelliformis *obtained at autopsy from snails infested with the sporocysts of* Schistosomatium douthitti *as compared with the length of those from uninfested controls. Both groups were given the same exposure to the cercariae of* Cotylurus flabelliformis.

Group 1. From snails infested with *S. douthitti.*				Group 2. From uninfested controls			
Snail number	Number of developing metacercariae recovered	Number measured	Average length in mm.	Snail number	Number of developing metacercariae recovered	Number measured	Average length in mm.
1	72	20	0.285	1	552	50	0.334
2	312	40	0.281	2	682	50	0.465
3	349	50	0.291	3	974	40	0.345
4	455	40	0.266	4	1,648	40	0.383
				5	2,806	50	0.355
Average			0.28				0.376

(*Stagnicola emarginata angulata* and *Fossaria obrussa*). Certainly this point should be tested further.

SUMMARY

In a series of three experiments performed at different times it was shown that snails of the varieties *Lymnaea stagnalis appressa* and *L. stagnalis perampla* infested with the sporocysts of the strigeid *Cotylurus flabelliformis* showed an immunity to the penetration of the cercariae and development of the metacercariae of this same species which normally penetrate and develop in these snail varieties. The results confirm the earlier preliminary studies of Winfield (1932). This immunity was not absolute and in one case an infested snail showed considerable development of the metacercariae stages. Direct observation on infested and uninfested snails exposed to the cercariae showed that while the cercariae penetrated actively and in large numbers into the uninfested snails, the great majority of them failed to show any penetration reaction when they came in contact with the snails infested with the same form. The differences in numbers of developing metacercariae found in the infested and uninfested snails after equal exposure to the cercariae was very striking.

Experiments to test whether there was a non-specific immunity to the penetration of the cercariae of *Cotylurus flabelliformis* in normal second intermediate hosts infested with larval trematodes of different species gave variable results. In the small snails, *Fossaria obrussa* (Say) penetration was tried on snails infested with the larval stages of two other strigeids and a stylet cercaria. In all three cases there were no significant differences between the number of metacercariae developing in the uninfested controls and in the infested groups. The same result was obtained with specimens of *Stagnicola emarginata angulata* (Sowerby) infested with the sporocysts of *Cotylurus communis,* a form in the same genus as the penetrating cercariae.

In the case of groups of *Lymnaea stagnalis perampla* and *L. stagnalis appressa* infested with the larval stages of a schistosome, *Schistosomatium douthitti* evidence of a partial non-specific immunity was obtained. In this case significantly larger numbers of the developing metacercariae of *C. flabelliformis* were present in the controls than in the infested groups and those present in the infested groups were much smaller showing a retardation in development.

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NEW SNAIL AND RABBIT HOSTS FOR *FASCIOLA HEPATICA* LINN.

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The occurrence of epizoötics of fascioliasis among sheep in the Rocky Mountain States has been responsible for an investigation to determine the intermediate hosts of *Fasciola hepatica* Linn. in that region. Several shipments of snails from Utah were negative when examined for liver fluke infections, possibly because they were taken in the spring months. In these shipments of snails, *Succinea avara* Say, *Lymnaea* (*Galba*) *palustris* Müll., and *L.* (*G.*) *obrussa* Say were identified by Mr. Wm. B. Marshall of the National Museum, and *Fossaria modicella* Say,[1] the most abundant snail, was identified by Dr. F. C. Baker, University of Illinois.

A number of *Fossaria modicella* was received from Utah on May 17, 1932; of these, 70 were dissected; all were negative for trematode infections. Forty of the remaining snails of this lot were isolated in a watch glass and subjected to attack by many miracidia of *Fasciola hepatica* which had hatched from eggs collected April 15, 1932, at Jeanerette, Louisiana. The miracidia promptly attached to the snails and worked their way into them. After 2 hours the miracidia, except for a few dead ones on the bottom of the container, had disappeared, and the snails were then transferred to a suitable container and fed on lettuce. Twenty-seven days later, 25 of the snails were dead; 4 had not disintegrated and examination showed these to contain many rediae of *F. hepatica* Linn. Four of the living snails were dissected the

[1] Dr. Baker states that these are *Fossaria* sp., "somewhat like *modicella* Say." Since the snails occur in such large numbers there seems to be little doubt as to their identity. *Fossaria modicella* is one of the most abundant of the lymnaeid snails in the Rocky Mountain region. According to Baker (1911), it occurs in practically all of the United States, north and west of the Alleghany Mountains. The experiments reported in this paper establish this snail as an important intermediate host of *Fasciola hepatica* in the United States, and it may prove to be the most important host for the Rocky Mountain States. The snails previously established as hosts in the United States are: *Galba bulimoides*, by Shaw and Simms (1929), and *G. ferruginea*, by Shaw (1931), both for the West Coast, and *G. bulimoides techella*, by Sinitsin (1929), for the South. *Galba cubensis*, established as a host in Puerto Rico by Van Volkenberg (1929) and by Hoffman (1930), occurs in Florida and doubtless serves as a host there. Sinitsin (1929) reported *Galba desidiosa modicella* to be immune to infection with *Fasciola hepatica*. Since there is no snail with such a name possibly an error was made by Sinitsin and, according to Mr. Wm. B. Marshall of the U. S. National Museum, the snail to which Sinitsin referred is *Stagnicola desidiosa*. The above explanation is given to avoid any confusion involving the names *Fossaria modicella* and *Galba desidiosa modicella*.

same day and were found to be infected. Nine of the 11 remaining snails were also infected and produced cercariae, the first snail beginning to shed cercariae 32 days after it had been subjected to the miracidia, and the last snail to shed them beginning in 42 days. The infected snails were all dead on July 23, 1932.

In spite of the small size of the snails, as many as 44 cercariae escaped from one snail in a day, the daily average being 5 cercariae per snail. The escape of the cercariae was erratic and several days would sometimes elapse without the escape of any cercariae. Cysts were found on the surface of the water, on the sides of the container, and on the fresh lettuce which was used for snail food.

Since only 2 of the snails in the experiment were not infected, and all infected snails began to shed cercariae within a period of 10 days, it is assumed that the snails were infected experimentally. The examination, with negative results, of the large number of snails in the shipment, from which the ones used in this experiment were selected, is in accord with the foregoing assumption; furthermore, 21 from the same lot were used in other trematode infection experiments, and no *F. hepatica* infections appeared even though the snails were kept for 6 weeks or more.

Laboratory-raised *Fossaria modicella* were also used in experiments with *F. hepatica* and gave interesting results. The snails were reared from eggs of snails collected in Utah, on March 28, 1932.

Snails only 7 to 10 days old were subjected individually to attack by a single miracidium, and when the miracidium had completely disappeared, the snails were returned to an aquarium. The miracidia penetrated slowly, 40, 45, and 75 minutes being necessary for those in which penetration was observed. Most of the snails became infected, but none shed cercariae. The reason for the failure of cercaria to escape was apparent when the snails were examined. It could be observed through their transparent shell that the greater part of the spire, except for the loop of the snail's intestine, was occupied by numerous rediae; the so-called liver was usually completely destroyed long before any cercariae were mature. In 27 days, large rediae, containing both daughter rediae and developing cercariae, had matured, and the snail which lived the longest, 33 days, harbored rediae with cercariae which were about ready to escape; the time necessary for the larvae to reach this stage also supports the contention that the infections discussed in the previous paragraphs were produced experimentally.

Numerous laboratory-raised *Lymnaea* (*Galba*) *palustris,* ranging in length from 1 mm. to 7 mm., were subjected to the attack of many miracidia of *F. hepatica* but none became infected.

Twenty-four laboratory-raised *Succinea avara,* none more than half grown, were subjected to attack by miracidia by confining the snails in covered watch glasses full of water except for a large bubble of imprisoned air, the snails being thus kept in intimate association with the miracidia. The snails attracted the miracidia which attached temporarily; several penetrated half their body length into the snail, but none of the miracidia were observed to disappear entirely. Twelve of the snails lived and were dissected, with negative findings, 21 days after being subjected to the miracidia. The relatively high mortality was not unusual for these small snails kept under laboratory conditions and, consequently, death was probably not the result of infection.

The cysts of *F. hepatica* which accumulated in the container in the experiment discussed earlier in this paper were used in infection experiments. A wild cottontail rabbit, *Sylvilagus floridanus mallurus* (Thomas),[2] which had been taken from a nest at an early age and fed on milk with a medicine dropper until able to take other food, was given a total of 37 cysts, over a 9-day period beginning June 20, 1932, after it had been kept in the laboratory for a month. Twenty days after the initial feeding of metacercariae, the rabbit was killed and examined post mortem; 25 immature flukes were recovered which, after being relaxed in water and killed in a corrosive sublimate and acetic acid solution, ranged in length from 1.5 mm. to 4.5 mm., an average of 3 mm. Another rabbit from the same litter was given 12 cysts on July 16, 1932, and kept under laboratory conditions; a fecal sample collected September 14, 1932, was negative, but a sample examined October 25, 1932, contained numerous eggs. Three adult flukes, about 20 mm. in length, were recovered post mortem on October 26, 1932.

An opossum, *Didelphys virginiana* Kerr, which was captured in Maryland when about half grown and still with the mother, was given 44 encysted *Fasciola hepatica* over a period of 5 days. No flukes were found post mortem when it was examined 120 days after the first cysts were administered.

SUMMARY

The snail *Fossaria modicella* Say has been determined experimentally to be a new secondary host of *Fasciola hepatica* Linn., and the cotton-tail rabbit, *Sylvilagus floridanus mallurus* (Thomas), to be a new primary host. Cercariae escaped from these snails which were subjected to infection when fully grown, in 32 days, but laboratory-raised snails infected when still small died before the cercaria-producing stage was reached. Laboratory-raised snails of the species *Succinea*

[2] Identification by Mr. G. S. Miller, U. S. National Museum.

avara Say and *Lymnaea* (*Galba*) *palustris* Müll. and an opossum, *Didelphys virginiana* Kerr, could not be infected.

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A NEW PIT-PRODUCING MITE FROM THE SCALES OF A SOUTH AMERICAN SNAKE

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A few years ago Doctor L. W. Sambon described for the first time two species of very unusual ectoparasitic mites taken from certain South American snakes, and erected for them a new genus, *Ophioptes*. These mites produced and inhabited small pits in the heavily cornified layer of the scales of the host. They belonged to the family Cheyle-

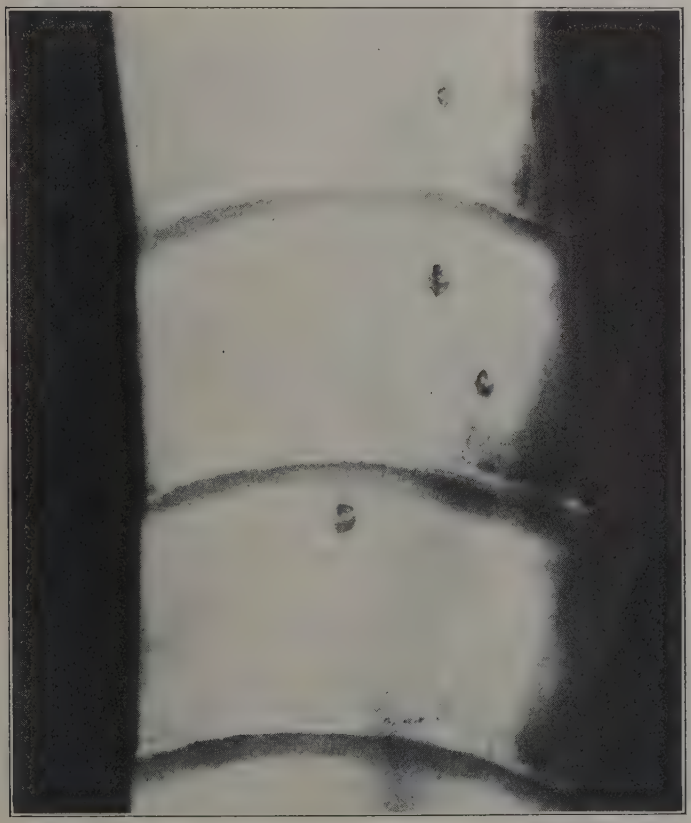


Fig. 1. Ventral view of the snake, *Erpetodryas carinatus*, showing the crater pits produced by *Ophioptes tropicalis*, new species, ×6. Photo by J. G. Pratt.

tidae, and appeared to be atypical in their life history. According to Doctor Sambon, only two instars were present in *O. parkeri,* the only one of the two species which he especially studied. One of these, which he called the puparium or nymph, was saclike and devoid of legs. Inside its swollen skin was found the fully formed, legged individual, described by Sambon as the male. He found no larvae or females in the case of this species.

In 1931 the writer had an unusual opportunity for examining here at Washington, D. C., many live snakes taken in South America by the British Guiana Expedition of the National Zoological Park. Among the scores of individuals of many species examined, one was found to be infested with a mite of the pit-producing type described by Sambon. This snake, *Erpetodryas carinatus* (Linnaeus), a marsh snake of the family Colubridae, was infested on its ventral side (Fig. 1) instead of above, as in the cases previously described. The pits were inside of very definite craters, and usually each was inhabited by a mite.

Two instars were present,—the swollen nymph and a form, inside this same nymph, which was of the type described by Sambon except that no genital orifice or penis appeared to be present. Sambon states that in the second instar of his species the sexual orifice is, "at anterior end of dorsal surface, slightly above level of interval between first and second pairs of legs." He also describes and figures a long, cylindrical penis. The second instar of the species found by the writer is of almost exactly the same type as Sambon's but upon being cleared shows no genital opening and no penis. Under these circumstances the present writer is inclined to regard it as a nymph. Sambon states that both sexes were present in the case of his second species, but does not differentiate between the two. This second species came to him at the moment his manuscript was going to press.

The species which the present writer found is new. In the final pit-infesting instar the three known species of *Ophioptes* may be separated as follows:

1. Each tarsus bearing at its tip two hollow divergent pads.
   O. oudemansi Sambon
   Each tarsus bearing at its tip a cup-shaped sucker 2
2. Capitulum and its palpi, as seen from above, together about as long as the former is broad at its base; dorsal setae small except for the sublaterals ..... *O. parkeri* Sambon
   Capitulum and its palpi, as seen from above, together only about half as long as the former is broad at its base; dorsal setae very large, conspicuous, those near capitulum as long as the palpi.
   O. tropicalis, new species

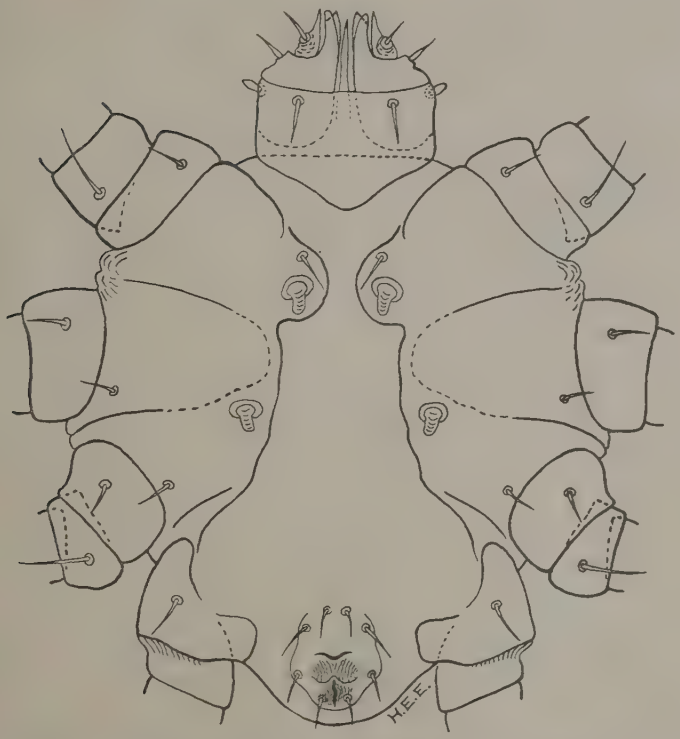


Fig. 2. Ventral view of body and mouth-parts of last pit-infesting instar of *Ophioptes tropicalis*, new species.

The new species of *Ophioptes* is described as follows:

Ophioptes tropicalis, new species.

Final instar in pit. ***Adult(?):*** Body very short, about as broad as long. Capitulum, not including palpi, about three times as broad as long, when viewed from above. Palpi reduced to either two or three segments, the basal much swollen, the penultimate ending in a stout, slightly curved, distally bifurcate claw; palpal thumb closely appressed to palpal claw, drawn out into a bladelike process distally and bearing a conspicuous spine near base. Chelicerae needlelike, elbowed near their bases. Body covered with soft, pliable skin; dorsal and ventral plates absent. Above, the body bears about a dozen large, conspicuous, simple setae. Below, the body is without setae except for the anal region. Anal region formed into a low, poorly-sclerotized, anal papilla. Anus a longitudinal slit, in front of which is a bilobed fold, and in front of this fold a transverse, sclerotized lip. Situated in anal region are four pairs of simple setae, the second pair being the largest. Legs stout, similar, each ending in a very short, pedicellate, cup-shaped sucker and two long, bifurcate, internally pectinate setae. First

coxal plate with toothlike tubercle near its base, in front of which is a seta; second coxal plate without toothlike tubercle but with a small seta near its distal margin; third coxal plate with tooth-like tubercle near its base and a small seta near distal margin; fourth coxal plate vestigial, fused with third.

Length, 0.35 mm.; width, 0.31 mm.

Type host.—A marsh snake, *Erpetodryas carinatus*.

Type locality.—Collected at Washington, D. C., on a snake just arrived from British Guiana.

Type slide.—U.S.N.M. No. 1081.

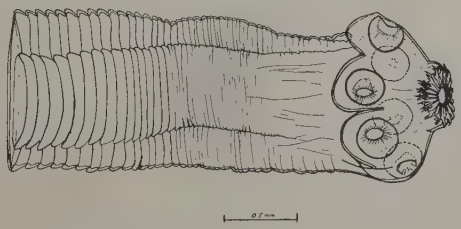
Described from five individuals of final instar in pits. These individuals probably are not adult, yet are of similar appearance to forms said to be males. If these specimens are adult, they must be females, as there is no indication of a penis being present. A few swollen nymphs were extracted, but they are not in good enough condition for description.

RESEARCH NOTES

The Editorial Committee has decided to establish this section, "Research Notes," as an experiment to make possible publication without undue delay of short notes on discoveries which do not lend themselves to publication as more extended articles. Such notes should not exceed a printed page in length including illustrations. It will be necessary to charge the cost of illustrations published in this section to the authors. Abstracts or preliminary reports of researches the results of which are to be published later in more extended form will not be included, the section being reserved for the final publication of new discoveries.

A Six-suckered Tapeworm, *Taenia hydatigenea* Pallas, 1766. Wm. P. N. Canavan, Department of Bacteriology, University of Oklahoma, School of Medicine.

An abnormal dog tapeworm was found in a collection of worms from experimental animals. Its scolex has a normal rostellum with a total of thirty-six hooks arranged in two rows of equal sizes; the larger hooks are 144 microns in length, the smaller are 90 microns in length; and the scolex has six definite acetabula. Commencing with the immature segments there is a smaller strobile superimposed upon the surface of a wider strobile and fused and continuous with it.



Quoting from Hegner, Root and Augustine's "Animal Parasitology" (1929: 317–318): "Abnormal forms, or malformations of *T. saginata* are very common and have been described as new species. These are now known, however, to be aberrant or immature specimens of *T. saginata*. . . . Bifurcation of the strobila of *T. saginata* has also been observed as well as scolices equipped with six suckers (*T. hybrida*)." My specimen I believe is the first *T. hydatigenea* Pallas, 1766, to be described with six suckers. This is evidence that such malformations may occur in the armed as well as in the unarmed members of the genus *Taenia*.

Starch Diets and Infections with *Endamoeba histolytica* in Chicks. Robert Hegner, Johns Hopkins University, School of Hygiene and Public Health.

A host diet containing a large proportion of starch has been shown to be favorable for the growth and multiplication of certain intestinal protozoa, and a host diet consisting largely of animal protein, to be unfavorable. These findings suggested the experiments recorded here. In a previous publication (Hegner, 1929[1]) the results of attempts to infect chicks with *Endamoeba histolytica* were presented. Of 17 chicks, 3 inoculated per os with *E. histolytica* in culture medium did not become infected; 4 inoculated per rectum with culture amoebae remained uninfected; but 2 of 10 inoculated per rectum with amoebae from an experimentally infected kitten were positive for 2 days.

[1] Hegner, R., 1929. Transmission of intestinal protozoa from man and other animals to parasite-free fowls. Amer. Jour. Hyg., 9: 529–543.

The availability of several strains of *E. histolytica* that were being cultivated by Menendez (1932[2]) led to the following experiments:

(1) Two chicks 2 weeks old that had been fed on a diet containing large amounts of starch and were then inoculated with *E. histolytica* of strain D did not become infected.

(2) Four starch-fed chicks that were inoculated per rectum with *E. histolytica* of strain C were negative on smear examination during the following three days but one culture inoculated at the end of 24 hours was positive.

(3) Four chicks were inoculated per rectum with *E. histolytica* that had been grown in culture with starch for a long period; 2 of these were positive at the end of 2 days but all were negative when examined on the following 5 days although the diet of the chicks was changed from normal chick starter to one consisting largely of starch.

(4) Rice starch was injected into the crop of 2 chicks on 3 successive days and then *E. histolytica* from strain A were inoculated per rectum; both chicks were fed largely on starch thereafter; both became infected; large numbers of amoeba were defecated by both at the end of 1, 2, 4 and 5 days, fewer amoebae were present on the sixth day; one was positive and the other negative on the seventh day; and both were negative on the eighth day.

These results indicate that infections with *E. histolytica* can be set up in chicks by rectal injection. An abundance of starch in the diet of the chick appeared to enable the amoebae to maintain themselves for a longer period in the ceca. There seems to be no question but that multiplication of the amoebae occurred within the chicks, since the material in the ceca is evacuated frequently thus carrying large numbers of amoebae out of the body, whereas the number of amoebae in the chick remained apparently about the same for a period of 5 days. It is possible, but not probable, that the endamoebae of strain A were more virulent than those of the other strains used.

[2] Menendez, P. E., 1932. Serological relationships of *Entamoeba histolytica*. Amer. Jour. Hyg., 15: 785–808.

REVIEWS AND NOTES

DIAGNOSTIC ET TRAITEMENT DU KALA-AZAR MEDITERRANEEN DE L'ENFANT ET DE L'ADULTE. By M. D'Oelsnitz, Physician to the Hospitals of Nice. Masson and Company, Paris, 110 pp., 18 figs., 1932.

This hand book is No. 56 of the "Collection Medecine et Chirurgie Pratiques." The preface by Professor Fernand Bezançon calls attention to the fact that although kala-azar in the Mediterranean region has been considered a disease of infants and that kala-azar in the adult has been thought to be only imported from other regions; it is now recognized that the adult disease is endemic in certain Mediterranean regions. Professor Bezançon calls attention to the timeliness of this monograph which he believes will fix attention on the extension of kala-azar in southern France and familiarize practicing physicians with the disease, thus contributing to its better treatment and ultimately to its control.

The monograph is divided into nine chapters. In the first chapter the disease in general is considered including its history, the discovery of the parasite, the relation of the human disease to that in dogs, and the possible relation of insects to transmission. The second chapter deals with the clinical diagnosis including prodromal symptoms, the fever, the progressive enlargement of the liver and spleen, the enemia, the pigmentation of the skin, minor symptoms, and complications. In the third chapter the author contrasts the clinical picture in the infant with that in the adult emphasizing the more rapid course and severe picture in the infant and the chronic nature of the disease with remissions in the adult. The fourth chapter deals with laboratory diagnosis including the various tests which are based upon the precipitation of the globulin in the blood, the globulin-albumin ratio, and the various methods of demonstrating the parasite by organ puncture, blood examination, and blood culture. Chapters five, six and seven are given over to the various forms of antimony treatment showing especially the excellent results obtained by pentavalent antimony preparations. Chapter eight deals with intolerance and resistance to antimony therapy, and chapter nine outlines non-specific treatment and points out the ineffectiveness of the removal of the spleen. An extensive bibliography follows dealing only with kala-azar in the Mediterranean region.

It is evident that the author has an excellent acquaintance with the disease as it occurs in this region as well as the extensive work done in India in the elucidation and treatment of the disease. The brevity and conciseness of the monograph and its availability to French physicians should make it a very important contribution to the diagnosis, treatment and control of kala-azar in France. It is of universal interest in calling attention to the importance of the disease in France and is a concise summary of our present knowledge of this important malady. It is especially commended for the accuracy of the observations made and should be widely used as a guide by both practitioners and laboratory workers.—H. E. MELENEY.

JOURNAL OF PARASITOLOGY ANNOUNCEMENT

Following the action of the Editorial Board of the JOURNAL OF PARASITOLOGY and the Council of the American Society of Parasitologists at a meeting held at Atlantic City the following changes will be made in volumes twenty and twenty-one of the JOURNAL OF PARASITOLOGY:

1. Volume 20 will be published in six numbers at intervals of three months beginning with September, 1933, and ending with December, 1934. Each number will be somewhat smaller than those of volume 19 and there will be no increase in price for the volume.

2. Volume 21 will coincide with the calendar year 1935 and will be published in six numbers as follows: no. 1. February; no. 2, April; no. 3, June; no. 4,

August; no. 5, October; no. 6, December. No increase in price is contemplated for volume 21.

The purposes of these changes is two-fold: (1) to make the JOURNAL year coincide with the Society year (the calendar year) and (2) to put it on a bi-monthly basis.

The Editorial Committee is gratified to be able to announce that for volume 19, which is completed with this number, there were slightly over 400 paid up subscribers from the American Society of Parasitologists and almost 400 non-society subscribers making a total of almost 800 paid subscribers who received all four numbers of the volume. While the financial report for the volume has not been completed it is expected that there will be a slight surplus, which will be applied to volume 20.

Unfortunately, as with almost all other scientific journals, there is an excess of manuscripts for the available space, so that copy is now at hand for over a year in advance. It is evident that publication facilities are becoming more and more inadequate in the field of parasitology and with an ever-increasing number of workers the situation promises to become worse. While it may become desirable in the future to increase the size of the JOURNAL OF PARASITOLOGY by increasing its price, any such change in the near future would obviously be unwise. At present two methods of meeting the situation suggest themselves. One would be to obtain outside funds for increasing the publication facilities of the JOURNAL. A step in this direction has already been made by the establishment of an endowment fund by the Society, the interest of which is to be used for increasing the size of the JOURNAL.

The other method is to increase the subscription list of the JOURNAL both by obtaining Society and non-society subscribers. Every two new subscribers for volume 20 in addition to the present list will make it possible to add more than a page to the volume size. It is evident, therefore, that a hundred or more new subscribers would add significantly to the amount of material that could be published during the coming year.

SURPRISE PARTY IN HONOR OF DR. WARD

In order to celebrate the completion of 24 years of service to the University of Illinois by Professor Henry Baldwin Ward, his colleagues, their wives and former students, seventy in all, gathered at his home on the evening of May 27, 1933, for a "surprise party." Mrs. Katherine H. Paul, who was in general charge of the arrangements, had so well engineered the event that both the party and the 17-foot Old Town Canoe, the gift of former students and colleagues, came as a complete surprise to Dr. Ward. With the canoe went a purse, the remainder of the gift, to pay for a new canoe house. During the course of the evening Dr. Ward was presented by Dr. Charles Zeleny, the new head of the zoology department, with a bound volume of letters from 125 friends from all over the world, written in honor of his retirement from active service as Professor of Zoology and Head of the Department.

AMERICAN SOCIETY OF PARASITOLOGISTS, ANNOUNCEMENTS

PRELIMINARY ANNOUNCEMENT OF THE 9TH ANNUAL MEETING OF THE AMERICAN SOCIETY OF PARASITOLOGISTS AT BOSTON, MASS., THURSDAY, FRIDAY AND SATURDAY, DECEMBER 28–30, 1933.

Pursuant to action of Council taken at Atlantic City, the A. S. P. will hold a three-day program in conjunction with the meeting of the A. A. A. S. at Boston. The headquarters hotel and the location for the regular sessions have not yet been assigned.

An especial feature of the program will be the opportunity to present scientific papers by demonstrations and charts. Actual demonstration rather than the description of research results affords the most satisfactory form of presentation. This method permits the presentation of many papers simultaneously, allows each member unrestricted time for the presentation of his material, and encourages the discussion of particular features in a more intimate and detailed manner than is possible after the formal reading of papers. Furthermore, members are not required to listen to reports in which they are not particularly interested. The demonstration tea is both a scientific program and a social function, a place where members can meet informally for the discussion of research or for just friendly banter. In every possible instance members are urged to present papers by demonstration. Abstracts of such papers should be prepared in the usual form. All abstracts must be in the office of the Secretary on or before November 1, 1933.

In conformity with the present tendency to curtail expense, the Society will not hold an annual dinner. Reverting to an earlier custom, there will be a luncheon, followed by the annual business meeting.

A joint session with Section N of the A. A. A. S. is contemplated.

HORACE W. STUNKARD, *Secretary.*

PROCEEDINGS OF THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

One Hundred Fifty-second Meeting

The one hundred fifty-second meeting was held January 21, 1933, in the United States National Museum, Dr. W. W. Cort presiding. The following minute was passed in regard to the death of Dr. Stumberg.

The sudden death of Dr. John E. Stumberg on January 20 from heart involvement following an attack of influenza came as a great shock to his friends and associates. During the period of his graduate study in Johns Hopkins University Dr. Stumberg was an active member of the society and contributed to its meetings. We appreciated him for his quiet unassuming manner, his sound accomplishment and his high ideals. His death just at the beginning of a promising career in research is keenly regretted by all those who knew him.

Papers were presented as shown below.

L. A. Spindler, Secretary.

1. Ascarops strongylina (*Rudolphi, 1819*), *the correct name for* Arduenna strongylina (*Rudolphi, 1819*) *Railliet and Henry, 1911, and* Ascarops minuta *Beneden, 1873.* Joseph E. Alicata and Allen McIntosh.

Van Beneden (1873) found some nematode larvae encysted in the stomach wall of a bat in Belgium and named the species *Ascarops minuta.* His descriptions and illustrations of the larvae show a set of characters in agreement with those of larval nematodes collected by us from the stomach wall and mesentery of the red bat, *Lasiurus borealis.* The larvae found by us are the larvae of *Arduenna strongylina,* as we have demonstrated by feeding some of them to a rabbit and recovering the mature worms a month later. Ono (1932) has reported similar results from experimental feedings in which larvae from a bat were fed to a rabbit and *Arduenna strongylina* subsequently recovered from this animal. In view of the rather distinctive structures of these larvae there appears to be no doubt but that the larvae found by van Beneden, Ono, and ourselves are cogeneric. Since *Ascarops* Beneden, 1873, antedates *Arduenna* Railliet and Henry, 1911, *Arduenna* falls as a synonym of *Ascarops.*

Ascarops minuta was designated as type of the genus *Ascarops* by Stiles and Hassall (1905) since this is the only, and hence type, species. At the present time the genus *Arduenna* contains three species, namely, *Arduenna strongylina* (Rudolphi, 1819), *Arduenna dentata* (Linstow, 1904), and *Arduenna kutassi* Shul'ts, 1927. We identified *Ascarops minuta* with *Arduenna strongylina* for the following reasons:

Arduenna strongylina occurs in swine in Belgium, and *Ascarops minuta* occurs in the bat in Belgium. The life history of *Arduenna strongylina,* as ascertained in the United States and Japan, may involve bats as intermediate hosts or as aberrant hosts. *Arduenna dentata* is known only from Asia, and *Arduenna kutassi* is known only from Asiatic Russia and the southern part of European Russia, and the life histories are not known for either of these, so that the possibility that they may have larval stages in bats is not yet known. Under the circumstances we feel justified in regarding *Ascarops minuta* as identical with *Arduenna strongylina.*

On the basis of the foregoing, we make the following proposals: The genus *Arduenna* to become a synonym of *Ascarops,* the species *Arduenna strongylina* to become *Ascarops strongylina, Arduenna dentata* to become *Ascarops dentata,* and *Arduenna kutassi* to become *Ascarops kutassi.* The subfamily Arduenninae Railliet and Henry, 1911, under this proposal becomes Ascaropsinae.

2. The development of the pre-parasitic larval stages of OSTERTAGIA CIRCUMCINCTA. JOHN S. ANDREWS.

Maupas and Seurat (1913) stated that the larvae of *Ostertagia marshalli* pass the first moult within the egg and emerge as second stage larvae. Apparently, therefore, this nematode differs from other members of the family Trichostrongylidae in this respect. In order to determine whether this is true in other members of the genus *Ostertagia,* eggs of *Ostertagia circumcincta* were collected and cultured and observed from day to day. The eggs were seen to hatch within 24 to 48 hours, typical first stage larvae emerging. No residual membranes were visible within the empty egg shells. At the end of four and one-half days, the culture showed the presence of second stage larvae, most of which were either in the second lethargus or ready to enter it. Infective larvae were found at the end of the sixth day. This period of development conforms with that of the free-living larvae of closely related nematodes.

3. Note on a genus and species of nematode from LYNX CANADENSIS. B. G. CHITWOOD.

As a result of a study of material collected by A. H. Twichell from *Lynx canadensis,* at Deadwood Creek, Distma River Flat, the author concludes that *Dirofilaria repens,* Railliet and Henry, 1911 is a synonym of *Filaria acutiuscula* Molin, 1858 and is hereby transferred, the n. comb. being *Dirofilaria acutiuscula* (Molin, 1858) n. c.

4. Notes on some saprophytes or semi-parasitic nematodes infesting plants. J. R. CHRISTIE.

The possible rôle of certain saprophytic or semi-parasitic nematodes in producing lesions and decayed areas on the underground portions of plants is beginning to excite considerable curiosity. The Division of Nematology is continually receiving plants with lesions or diseased areas infested with nematodes. Among the species most commonly encountered are *Cephalobus elongatus, C. oxyuroides, Acrobeles bütschlii, Aphelenchoides parietinus,* and *Aphelenchus avenae.* Recently an examination was made of 86 cotton seedlings affected with the so-called "sore shin" disease, collected from three different localities in South Carolina. *Aphelenchoides parietinus* was found in the diseased areas of 76 per cent, *Aphelenchus avenae* in 50 per cent, and *Cephalobus sp.* (largely *C. oxyuroides*) in 58 per cent. There is no reason for doubting the importance of certain fungi in this connection. But are the nematodes to be regarded as secondary invaders of little or no significance or do they play a more important rôle? It has been demonstrated experimentally that *C. oxyuroides* will produce definite lesions on the hypocotyls of cotton seedlings and small larvae of this same species have been found coiled within apparently healthy cells. There is considerable evidence in support of the view that such nematodes may enlarge the lesions and render the plants less likely to recover. A solution of this problem, apart from its bearing on this important cotton disease, would be of considerable significance. It would enable us to answer in a more definite manner the numerous questions which are being asked regarding the pathogenicity of these nemic species.

An outgrowth of our investigations of cotton seedling diseases has been an attempt to rear the various nematodes involved on culture media. This appeared to be the only practical means by which a large amount of living material of a given species can be obtained. As a result, all the nematodes mentioned above have been successfully reared. The work has not proceeded to a point where definite statements can be made regarding the most suitable media for the various species. In all cases the nematodes have been grown on cultures together with bacteria or bacteria and fungi. It is exceedlingly difficult to transfer specimens to a culture without contaminating it with other organisms and even

if possible it would probably not be desirable. Many species of *Rhabditis* and at least several species of *Diplogaster* seem to find optimum conditions in a comparatively moist, sometimes even semi-fluid, bacterial growth. Nutrient agar is a suitable medium for such species. Excessive bacterial action seems to be detrimental to *Aphelenchus avenae.* It prefers a less putrescent environment with but a thin film of moisture on the surface. Prune agar and corn meal agar have been successfully used. The problem under such conditions is to prevent mold from overgrowing the culture. On several occasions nearly all the specimens of *A. avenae* were clustered over developing mold colonies indicating that the presence of fungi is at least not objectionable to this species. However, an excessive mold growth defeats the purpose of the culture. It appears, from limited experience, that the character of the accompanying fungal and bacterial growth is as great a factor in determining the success of a culture as the composition of the medium. Undoubtedly a great many nematodes can be successfully grown on cultures. This offers an opportunity for the study of habits and life histories and provides material for experimentation in a way that cannot be accomplished by any other method.

5. The effects of aqueous solutions of crude ammonium thiocyanate upon the larvae of the root knot nema, CACONEMA RADICICOLA. CORINNE COOPER.

Experiments have been conducted in various parts of the United States to determine the effectiveness of crude ammonium thiocyanate (NH_4CNS) as a herbicide. The question of what subsequent effects the salt remaining on the soil would have on soil organisms led to the following tests.

Larvae of *Caconema radicicola,* the root knot nema, were placed in aqueous solutions of crude ammonium thiocyanate made up into various strengths to determine the concentrations of this salt in water that are lethal to these organisms. *C. radicicola* larvae placed in a solution of 240 grams of NH_4CNS per liter of water (approximately 2 pounds of salt per gallon of water) became quiescent in 2 to 3 minutes, but revived when placed in fresh water after 5 minutes exposure to the solution. No larvae revived when placed in fresh water after 10 minutes in the above solution. Similar results were obtained by using a solution of 120 grams of NH_4CNS per liter of water (1 pound per gallon). Larvae placed in a solution of 60 grams of NH_4CNS per liter of water (½ pound of the salt per gallon of water) became quiescent in 5 minutes and were all dead in 20 minutes. The numbers of larvae reviving in fresh water after shorter periods of exposure to the above solution are as follows: after 5 minutes exposure all revived; after 10 minutes exposure 30 per cent revived; after 15 minutes exposure 3 per cent revived. Using a solution of 30 grams per liter (or approximately ¼ pound of the salt per gallon of water), 100 per cent of these nemas revived in fresh water after 20 minutes exposure to the action of the solution. After 30 minutes, 93 per cent revived; after 1 hour, 50 per cent revived; after 3 hours none of the larvae revived. Larvae in a solution of 15 grams of NH_4CNS per liter of water (⅛ pound of this salt per gallon of water) became quiescent within 30 minutes. However, when transferred to fresh water, all these larvae revived after 1 hour's time. After 2 hours exposure to this solution, 90 per cent of the larvae revived; after 6 hours exposure 10 per cent revived; after 7 hours exposure to the chemical all the larvae were dead. Larvae exposed for 24 hours to a solution made up of 7.5 grams of the above chemical in 1 liter of water (1 ounce per gallon) did not revive in fresh water. Larvae exposed to the solution until they became quiescent (1 hour) and then transferred to fresh water revived after 6 hours.

Although at least 200 larvae of *C. radicicola* were used in each of the above tests, the results can only be approximately correct because each lot of crude ammonium thiocyanate will vary in the percentage of impurities present.

6. A new host of TYLENCHUS DIPSACI (*Kühn*) *from Oregon.* W. D. COURTNEY.

Three species of *Ranunculus, R. acris* L., *R. auricomus* L., and *R. repens* L., are known to be hosts of *Tylenchus dipsaci* in Northern Europe. A fourth species, *R. occidentalis* Nutt., is attacked by the same parasite in Oregon, collected first in June 1929 at Salem by Dr. F. D. Bailey. The symptoms developed by the host seem to be the same as those observed in the other species: malformations in the leaves and swellings of the stems (Fig. 1).

7. The localization of Ostertagia in the host animal. G. DIKMANS.

It is generally reported that *Ostertagia ostertagia* in cattle are found in nodules in the wall of the fourth stomach. In contrast to this, however, post-mortem examinations made of a large number of animals in southern Louisiana where this parasite is prevalent, failed to reveal the presence of nodules that could be definitely attributed to this nematode, the parasites usually being located beneath a layer of mucus in the pyloric end of the 4th stomach. In regard to the location of *Ostertagia circumcincta* in sheep, a recent examination of 140 sheep stomachs (abomasa) showed that this nematode was present in about 130 cases. In all of these cases they were found in the pyloric end of the abomasum. In only one of the 140 animals examined were nodules found in the wall of the abomasum. Examinations of these nodules was entirely negative for nematodes.

8. NEOCOLPOCEPHALUM, *a new name for the Mallophagan genus* FERRISIA *Uchida.* HENRY E. EWING.

The genus *Ferrisia* was established by Uchida in 1926 for several species of biting lice that are parasitic for the most part on birds of prey. It represents a segregate, derived from the long established genus, *Colpocephalum* Nitzsch, and has as its type, by original designation, *Colpocephalum turbinatum* Denny. Recently my attention has been called to the fact that Fullaway established the genus *Ferrisia* for some scale insects in 1923, hence a new name must be provided for Uchida's Mallophagan genus. The name *Neocolpocephalum* is here

suggested for that purpose. When Uchida erected his genus *Ferrisia* he allocated to it ten species; in addition to these ten, two others should be added, *Colpocephalum flavescens* Nitzsch and *Colpocephalum spineum* Kellogg.

9. *Notes on cestodes of poultry.* M. F. Jones.

The California valley quail, *Lophortyx californica,* is reported as host for the poultry tapeworm, *Hymenolepis carioca.* The specimens were sent to the Zoological Division by Dr. E. J. Moore, from Winston-Salem, North Carolina.

The ground beetle, *Celia muscula,* is reported as an additional intermediate host for *Raillietina magninumida,* a tapeworm of the guinea fowl. Two naturally infested beetles were collected and an additional specimen was infested after having been fed segments of the tapeworm. A chicken and a turkey remained free from tapeworms after being fed tapeworm cysts from *Celia muscula.* A guinea fowl given cysts on June 10 and June 30, 1932, was passing gravid segments of *Raillietina magninumida* on July 28. This bird was killed on January 13, 1933, at which time 4 specimens of this tapeworm were recovered.

10. *The nematode* Cylindrogaster longistoma *(Stefanski) Goodey, and its relationship.* G. Steiner.

In ginger roots, originating from China and intercepted in Detroit, Michigan, there were found large numbers of *Cylindrogaster longistoma* (Stefanski 1922 and 1928),[1] (Goodey 1927).[2] This is not only a species rarely observed but also one of very interesting structure. It is not intended to redescribe this form now but to call attention to various heretofore overlooked features which are of great interest from a morphological, taxonomic and phylogenetic point of view.

An exact analysis of the head sense organs has not been previously made; as shown in Fig. 1A, there is a full set of cephalic papillae, the anterior as well as the posterior circle being complete. The anterior circle has a papilla in each lateral and submedial sector; the posterior has also the full number,—two submedian and a single lateral each. It can be seen in a front view (less readily, in side view) that in the posterior circle, the lateral, the latero dorso-submedial, and the latero ventro-submedial papillae are larger in size than the others. Compared with *Rhabditis,* the present form has therefore a differentiation in these papillae which suggests the beginning of reduction in their number. Otherwise the arrangement and the number of these papillae are absolutely reminiscent of those of the genus *Rhabditis.* This is also true for the amphids, which, as drawn in Fig. 1A–C, open behind the lateral papillae but are shifted slightly dorsad.

It is the buccal and esophageal regions which at first present features very different from those of *Rhabditis.* However, a closer examination reveals very interesting homologies. Most of the structural parts as seen in *Rhabditis* are still present. It may be well to introduce here some new terms which were worked out in collaboration with Dr. B. G. Chitwood of the Zoolgical Division, Bureau of Animal Industry, and Mr. J. R. Christie of this division. In using these terms we make the first attempt at a comparative morphology of the stomatal and esophageal parts of nematodes. Such studies will eventually lead to an understanding of the mutual relationships of the many types of stomatal structures found in this animal group and be basic for a classification.

If the *Rhabditis* structures are considered first (Fig. 1D) there is the oral opening and a short cavity with half-moon-shaped thickenings in the wall; for

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[1] Stefanski, W., Excrétion chez les Nematodes libres. Disciplinarum Biologicarum Archivum Societatis Scientiarum Varsaviensis. Vol. 1. Fascic. 6:12–13. 1922.

————, Sur l'identité des especés *Rhabditis longistoma* Stefanski, 1922 et *Cylindrogaster coprophaga* Goodey, 1927. Jr. Helminth. 6:77–78. 1928.

[2] Goodey, T., *Cylindrogaster coprophaga* gen. et. sp. nov. A Nematode found in a Culture of Faeces from a Wild Brown Rat. Jr. Helminth. 5:25–32. 1927.

these thickenings the term *cheilorhabdions,* and for this cavity the term *cheilostom* is proposed. Posteriorly there follows the cylindrical buccal cavity typical for this genus and for which the term *protostom* is proposed, its walls exhibiting rodlike thickenings,—the *protorhabdions.* The protostom is followed by another short, but wide cavity, the *telostom,* with walls again of half-moon-shaped thickenings,—the *telorhabdions.* Then follows the esophagus proper.

In *Cylindrogaster* the very same regions and parts, except the telorhabdions, may be observed. The cheilostom is equally distinct but the cheilorhabdions are here stronger and straight. The protostom of *Cylindrogaster* is much longer and more flexible than that of *Rhabditis,* but otherwise similar. The telostom also is still present but the walls are not thickened; the telorhabdions have disappeared. It might be mentioned that the protostom in e. g. *Cephalobus, Acrobeles,* etc. is subdivided by a separation of the protorhabdions into three successive portions. For these the terms *pro-, meso-,* and *metarhabdion* are proposed with *prostom, mesostom,* and *metastom* as the names of the relative portions. Even *Rhabditis* shows this subdivision to some extent. In Fig. 1B and C the esophageal tissue is seen enveloping a portion of the protostom, corresponding to the meso- and metastom, whereas the prostom is left free.

Of great interest is the large anterior esophageal bulb of *Cylindrogaster* if homologized with the same portions of the *Rhabditis* esophagus. This bulb is without doubt homologous to the corpus and median bulb, the corpus of *Cylindrogaster* being enlarged and more muscular than in *Rhabditis.* Its character as corpus is sustained by a break in the tissue where the real median bulb begins (Fig. 1E) and by the fact that the esophageal glands open immediately behind the telostom. The posterior portion of the esophagus, however, places *Cylindrogaster* close to the diplogasterids, as does also the male tail. It might be mentioned that the present form has deirids (or "cervical papillae" of earlier authors). Males were decidedly less numerous than females, the sexual number being 30.4.

Dr. Chitwood kindly called my attention to the close similarity of *Leptodera macrolaima* Schneider, 1866[3] to *Cylindrogaster longistoma* as here described. Schneider's species indeed differs from the present one in only three characters: Schneider says there are no lips. His drawing shows the corpus and anterior bulb of the esophagus as forming one spindle-shaped bulb, whereas in the present form it is cylindrical. There is also a slight difference in the arrangement of the male papillae in that the narrow bursal membrane has only three ribs, whereas in the present form there are four. Otherwise the arrangement and number of the papillae on the male tail end in *macrolaima* are identical with those in *longistoma.* We consider it therefore highly probable that Schneider's *Leptodera macrolaima* is in fact our *Cylindrogaster longistoma,* or, if not, at least a very closely related species. It is perhaps best to wait for the final decision in this regard until specimens from the neighborhood of Berlin, Germany, have been restudied. In regard to *Cylindrogaster ulmi* Goodey 1930,[4] it would perhaps be best to place this form in a separate genus, since the male is much more Rhabditis-like with its well developed bursa, and the female is prodelphic as opposed to an amphidelphic arrangement in the present species.

Myctolaimus Cobb 1920,[5] is another genus of the present group, although Cobb thinks it related to *Cephalobus.* The esophageal structures, however, are strictly those of the cylindrogasters whereas the characters of the male tail and the amphidelphic female apparatus may justify its standing as a separate genus.

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[3] Schneider, Anton. Monographie der Nematoden. Berlin, 1866. p. 159, tabl. XI, fig. 5a–b.

[4] Goodey, T. A new species of the nematode genus Cylindrogaster. Jr. Helminth. 8:89–92. 1930.

[5] Cobb, N. A. One Hundred New Nemas. Contributions to a Science of Nematology IX. Waverly Press, Baltimore. p. 276. 1920.

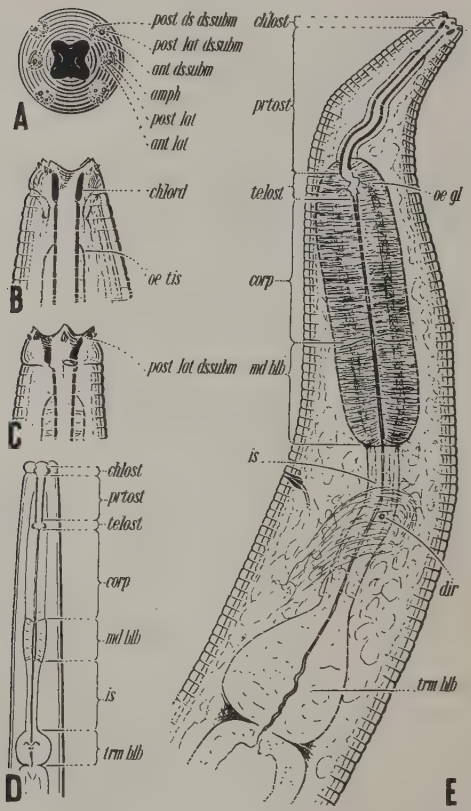

Fig. 1. A.—Front view of head of *Cylindrogaster longistoma: post ds dssubm;* posterior dorso dorso-submedial papilla; *post lat dssubm,* posterior latero dorso-submedial papilla; *ant dssubm,* anterior dorso-submedial papilla; *amph,* amphid; *post lat,* posterior lateral papilla; *ant lat,* anterior lateral papilla. ×1580. B.—Dorso-ventral view of head of *C. longistoma: chlord,* cheilorhabdion; *oe tis,* esophageal tissue, extending up to the prostom. ×1580. C.—Lateral view of head end of *C. longistoma: post lat dssubm,* posterior latero dorso-submedial papilla. ×1580. D.—Schematic Rhabditis, showing divisions of stomatal and esophageal regions: *chlost,* cheilostom; *prtost,* protostom; *telost,* telostom; *corp,* corpus; *md blb,* median bulb; *is,* isthmus; *trm blb,* terminal bulb. E.—Anterior end of *Cylindrogaster longistoma:* labels as in D, and, in addition: *oe gl,* outlet of esophageal gland; *dir,* deirid. ×790.

11. Occurrence of Amidostomum spatulatum *in the United States.* E. E. Wehr.

This species of *Amidostomum* was described by Baylis in 1932, and was reported from the bean goose, *Anser fabilis,* from England. There has recently come to my attention a few nematodes collected from underneath the tunic

lining of the gizzard of a Canadian goose, *Branta canadensis,* sent in by Dr. J. J. Levine from Albany, New York. An examination of these nematodes showed that there were several specimens of *Epomidiostomum crami* and a few specimens of *Amidostomum spatulatum* present. The latter species has not, up to the present time, been reported from birds in the United States. In his description of *Amidostomum spatulatum,* Baylis speaks of the anterior end as bearing two small dorsal and two small ventral "epaulette-like lappets," and states that each lappet corresponds to each of the submedian papillae. A study of the *en face* view of the head of this species clearly demonstrates these "epaulette-like lappets" to be merely cuticular expansions capping the laterodorsal and lateroventral papillae.

One Hundred Fifty-third Meeting

The one hundred fifty-third meeting was held February 20, 1933, in the United States National Museum, Dr. Benjamin Schwartz presiding.

Papers were presented as listed below.

L. A. Spindler, Secretary.

1. The status of Spirocerca sanguinolenta *(Rudolphi, 1819) Seurat, 1913.* B. G. Chitwood.

Strongylus lupi Rudolphi, 1809, has long been listed as a synonym of *Spirocerca sanguinolenta* (Rudolphi, 1819). Examination of the original descriptions of the two species shows that they are apparently identical and that Rudolphi so considered them. He originally named the species *Strongylus lupi* on the basis of another worker's observations. In 1819 he gave the name *Spiroptera sanguinolenta* with the synonym, *Strongylus lupi,* and additional descriptive matter from his own observations. From these facts it would appear that *Spirocerca sanguinolenta* has never been the valid name for this species and that its correct name should be *Spirocerca lupi* (Rudolphi, 1809) n. comb.

2. On the dissemination of a diplogasterid. J. R. Christie and Louise Crossman.

In a paper read before this Society (J. Parasit., v. 9, p. 36), Dr. N. A. Cobb called attention to a certain apogeotropic nematode larvae found on and in dung beetles (*Aphodius fimetarius,* etc.). These larvae, according to Cobb, extrude through the mouth an oily substance which enables them to crawl on dry surfaces. In a former paper (J. Parasit., v. 16, pp. 250–256) the senior writer described three species of similar larvae found on insects and pointed out that insects must play an important rôle in the transportation of nematodes.

Recently the Division of Nematology, U. S. Dept. of Agriculture, received some diseased ginger roots imported from China and intercepted at Boston by inspectors of the Bureau of Plant Quarantine. The decayed portions of these roots were infested by a diplogasterid nematode which was successfully reared on artificial media. The species is exceedingly prolific and the cultures were soon inhabited by numerous larvae. Many of these larvae ascended protruding objects, especially aerial fungus mycelium, and each, attached by its posterior extremity, waved the anterior part of the body in a circular manner. On some cultures hundreds of these "waving" larvae were to be seen on the fungus mycelium and presented a striking spectacle. On microscopic examination these larvae closely resembled some previously found by the senior writer on the surface of the beetle *Ips calligraphus* from Bogalusa, Louisiana.

A cockroach (*Blattella germanica*), captured in the laboratory, was placed in one of the cultures, allowed to remain for 24 hours, then removed and kept in a dry environment for seven days. It was then killed and placed on a fresh agar plate. In a few minutes nematode larvae of this species were seen leaving the insect and moving over the surface of the agar. Adult, ovipositing females

developed from these larvae in about 72 hours. Males were not seen in any of the cultures.

A quiescent stage on the surface of an insect is not essential to the life cycle, for "waving" larvae, transferred direct to an agar plate, promptly developed to maturity. It is interesting to note that not all the larvae on a culture exhibit this peculiar behavior and the two types are morphologically distinguishable. Cobb had noted the occurrence of two types of larvae (unpublished notes) in the case of *Diplogaster aerivora* Cobb 1916. These "waving" larvae are veritable "hitch hikers" which mount to an advantageous position and there await the passing of some accommodating insect.

This nematode apparently belongs to the genus *Lycolaimus* Rahm, 1928. It closely resembles *L. iheringi* Rahm, 1928, but differs from it in possessing an esophagus proportionately somewhat shorter.

3. Report of a few preliminary tests on the effect of some arsenic compounds on some plant parasitic nemas. CORINNE COOPER.

As a result of the use of calcium arsenate against the boll weevil in the south, and the subsequent reduction in the growth of cow peas and cotton, experiments were conducted in South Carolina to determine the effect of an excess use of this salt. This led to a consideration of the effect of the salt on the nemas in the soil. In connection with this arose the question of the effect of the relation of the arsenic fungi (see Thom, Charles and Raper, Kenneth B., Science, v. 76, No. 1980, 1923. pp. 548–550), i. e., whether the presence or absence of a cacodyl compound enhanced or inhibited the effect of the arsenic compound alone.

The following preliminary tests were made. Plates of Czapek agar were made up with a solution of As_2O_3 in such a manner as to result in the presence of 0.1, 0.01 and 0.05 per cent As_2O_3 in the agar.

In the beginning, *Caconema radicicola* larvae, *Cephalobus elongatus* and *Rhabditis lambdiensis* were placed on plates containing 0.1 per cent of As_2O_3, one series inoculated with *Penicillium brevicaule*. One hundred specimens were used in each plate throughout the experiments. All the nemas died within 24 hours on the plates containing the arsenic whether inoculated or not, while on the control plates of plain Czapek agar, all lived, the *Cephalobus* and *Rhabditis* plates becoming very good cultures, and some of the *Caconema* larvae living for 5 or 6 days. The same species of nemas were then placed on plates containing 0.01 per cent of As_2O_3, one series being inoculated with the fungus and the other series plain. In this instance, the *Caconema* larvae died, while most of the *Rhabditis* and *Cephalobus* survived for at least 4 or 5 days. On plates containing 0.05 per cent of As_2O_3, again all the nemas died within 24 hours. On plates containing calcium arsenate made up to contain equivalent per cents of arsenic calculated as As_2O_3, the same results were obtained. Two series of plates containing 0.01 per cent and 0.05 per cent of As_2O_3 respectively, were then made up, one series being inoculated with *Penicillium brevicaule* and the other plain. About 100 *Tylenchus dipsaci* in all stages of development were placed on these plates. On all the plates, including the controls, at least 20 per cent of the specimens survived for 3 days. In these preliminary tests, the presence of the fungus seems to make no appreciable difference in the relative detrimental effects of the different percentages of arsenic in the plates. Further experiments are now in progress to determine the effect of solutions of calcium arsenate, As_2O_3, etc. on the nemas when the specimens are placed directly in the solutions.

Analysis of three soil samples of Greenville loam brought from McLauren's farm, South Carolina, gave the following results: One sample treated with 2,500 pounds of calcium arsenate to the acre contained 54 nemas in 100 cc. of soil. Another sample treated with 500 pounds of this chemical to the acre contained 69 nemas in 100 cc. of soil. A control sample which had been untreated contained 180 nemas per 100 cc. of soil.

4. EUSTRONGYLIDES IGNOTUS *from the black-crowned night heron.* ELOISE B. CRAM.

Nematodes submitted by the Bureau of Biological Survey collected by W. H. Ball from the intestines and omentum of a black-crowned night heron (*Nycticorax nycticorax hoactli*), taken in the Potomac River at Washington, D. C., have been identified as *Eustrongylides ignotus*. This constitutes a new host record. Examination of these specimens and of specimens in the collection of the Zoological Division, from the great blue heron, *Ardea herodias,* allow of the following additions to the description of this species: *Male* up to, and probably exceeding 13 cm. in length. In a specimen 13 cm. long, spicule 8.6 mm. long; in an incomplete specimen, which judging from its width was probably more than 13 cm. long, spicule was 10.3 mm. long. *Females* 9 to 18 cm. long.

5. *Results of some experiments on the effect of the hotwater treatment upon* TYLENCHUS DIPSACI *as present in dried narcissus material.* GRACE W. SHERMAN.

Up to the present time the hotwater treatment of narcissus bulbs as a method of controlling *Tylenchus dipsaci* infestations has not been entirely satisfactory. It is therefore important to discover what factors may prevent complete eradication of these nemas by such treatments. Since *Tylenchus dipsaci* is noted for its ability to survive desiccation, dormant specimens as they may exist in infested bulb material present a serious problem because of their resistance in this condition. The assumption that dried infested narcissus bulbs may harbor, in dried leaves and scales, dormant *Tylenchus dipsaci* seems well based.

Laboratory tests were made to determine the per cent of survival of *T. dipsaci* after hotwater treatments of the following: dried leaves, presoaked and not presoaked; hard bulbs; soft bulbs; hard and soft bulbs together; presoaked bulbs; nemas picked into water and then treated. All treatments were made under a constant temperature of 44° C. or 111.2° F. *Tylenchus dipsaci* in heavily infested, dried narcissus leaves treated for 3, 3½, 4, 4½, 5, 5½ and 6 hours showed a maximum revival of from 50 per cent to 22.5 per cent, respectively. (Based on approximately 1000 nemas counted from each of 7 samples.) In presoaked leaves treated at 3 and 6 hours, *T. dipsaci* showed a maximum revival of 10 per cent and 0.6 per cent, respectively. (Based on 500 nemas picked from each of the two samples and kept isolated in water.) In hard narcissus bulbs treated for 3 and 6 hours, there were no revivals in 1,500 T. *dipsaci* picked from each sample. (Material discarded after a month's observation.) In the case of soft and decayed bulbs treated for 3 and 6 hours, none of the 1,000 nemas picked from each of the two samples survived. (Material discarded after 2 months' observation.) In mixed samples of hard and soft bulbs treated for 3 and 6 hours, there was a maximum revival of 1 per cent about a month after treatment in the 3 hour sample. None of the nemas from the 6 hour sample revived. (500 nemas from each sample were used.) When bulbs were presoaked 24 hours and then treated 3 hours none of the larvae survived. (Based on 2 samples of 500 each, discarded after 2 months' observation.) In the case of bulbs presoaked for 12 hours and then treated 3 hours, only 2 of 100 nemas picked from samples were found to be alive. This material was discarded after 2 months' observation. In the case of active *T. dipsaci* (4 samples of 500 nemas each) picked from bulbs and treated in glass tubes for 3 hours, the number of larvae which revived varied from a maximum of 12.6 per cent to a minimum of 1.6 per cent in the four lots. Five hundred active nemas were picked from bulbs and kept in water for 10 days before they were exposed to the "hotwater" treatment. Nine per cent of these nemas revived.

The results of these tests indicate that under the above conditions, "hotwater" treatment is less effective in killing *T. dipsaci* in dried plant material, than in any other kind. The number of nemas which survive this treatment in bulbs is considerably less than the number that survive in leaves. Treatment of

infected material for 6 hours was found to be more effective in killing *T. dipsaci* than treatment for a shorter period of time (3 hours). Presoaking the infested plant material in water greatly increases the efficacy of the "hotwater" treatment, fewer nemas reviving after treatment following a 24 hour presoaking period than revived when the treatment followed a 12 hour presoaking period. These preliminary results are to be considered only as indications of what may be expected to happen, and not as conclusive evidence of what will occur in treating larger quantities of infested plant material under commercial conditions.

6. Relation of vitamin A to the development of a resistance in rats to superinfections with an intestinal nematode, NIPPOSTRONGYLUS MURIS. L. A. SPINDLER.

Two tests were conducted to determine the relation of vitamin A to the development, in rats, of a resistance to superinfections with an intestinal nematode, *Nippostrongylus muris*. Resistance to superinfections with this parasite was first discussed by Schwartz, Alicata, and Lucker (1931). In carrying out the tests referred to in this paper albino rats were fed a diet deficient in vitamin A but adequate for all other dietary factors; control rats were fed a diet adequate for vitamin A as well as all other dietary constituents. Test and control rats were infected percutaneously with equal numbers of infective *N. muris* larvae. After worm eggs had ceased to appear in the feces of all the animals, they were given a second, or superinfection, using the same numbers of larvae which were given in the initial infection. To obtain an indication of the severity of the infections, counts were made at regular intervals of the number of worm eggs in the feces of each animal throughout the tests. After the worm eggs from the second infection had ceased to appear in the feces, the rats were autopsied. The results of the 2 tests are summarized below.

The patent periods of the worms infecting the vitamin A deficient rats in the superinfection of Test 1, was 64 to 67 days as contrasted to a patent period of 11 to 14 days in the superinfection of the controls. The peak of the average egg production of the worms in the vitamin A deficient group of rats was 41,000 eggs per day, in the superinfection, as compared to 250 eggs per day in the superinfection of the controls. In Test 2 the patent period of the worms in the superinfection of the vitamin A deficient rats was 31 days with a peak of egg production of 2,600 eggs per day, as compared to a patent period of 20 to 21 days with a peak of egg production of 1,500 eggs per day in the superinfection of the controls.

On post-mortem examination of the rats in Test 1, an average of 5 larvae was recovered from the lungs, and an average of 139 female worms was taken from the intestines of the rats fed a vitamin A deficient diet. In contrast to this an average of 68 larvae was recovered from the lungs and 7 female worms were recovered from the intestines of the control rats which had been superinfected. Similar results were obtained in Test 2, 5 larvae being found in the lungs and 60 female worms in the intestines of the superinfected rats fed a vitamin A deficient diet. On the other hand, an average of 27 larvae were taken from the lungs and 17 female worms from the intestines of the superinfected control rats.

The above results indicate that the lack of vitamin A in the diet of the experimental rats had lowered the resistance of these animals to a superinfection with *N. muris*. In contrast to this the rats fed a balanced diet developed a marked resistance to superinfection such as was described by Schwartz, Alicata and Lucker. Additional experiments are in progress to test further the relation of this vitamin to the resistance of rats to this parasite. The results of these tests together with the complete data from the above tests will be reported in detail later.

One Hundred Fifty-fourth Meeting

The one hundred fifty-fourth meeting was held March 18, 1933, in the United States National Museum, Dr. G. F. Otto presiding.

Papers were presented as listed below.

L. A. SPINDLER, Secretary.

1. The development of the swine nodular worm, OESOPHAGOSTOMUM DENTATUM, *in the guinea pig and rabbit.* JOSEPH E. ALICATA.

On December 23, 1932, each of four guinea pigs was given 3000 infective larvae of *Oesophagostomum dentatum,* by mouth. Two of these animals, killed 14 days after experimental infection, showed numerous small raised nodules about 1 mm. in diameter, scattered through the walls of the cecum and colon. Each nodule contained a larva of *O. dentatum* which was enclosed in a cyst, 400 μ to 550 μ in diameter. The lymph follicles of the cecum showed considerable inflammation; these follicles also contained *Oesophagostomum* larvae. Some of the follicles contained as many as 30 encysted larvae. Most of the larvae from these two host animals were still in the third-stage of development and were from 500 μ to 577 μ in length by 26 μ to 34 μ in maximum width. In one guinea pig two fourth-stage larvae, having well developed primary buccal capsules, were found in the lymph follicles of the cecum. These larvae showed the following size relationships: length, 1250 μ and 1482 μ respectively; width, 106 μ esophagus, 182 μ and 190 μ respectively; tail, 114 μ in length. It is of interest to note that in the wall of the small intestines of these guinea pigs there were found two encysted third-stage *Oesophagostomum* larvae. Histological sections of the infected lymph follicles of the cecum showed fibrous connective tissue surrounding each larva. The other two guinea pigs, killed 26 days after infection, showed approximately the same lesions as noted above. The larvae, which were encysted, were still in the third-stage of development. Some of the cysts showed granular material indicating progressive degeneration.

On February 4, 1933, a rabbit was fed 3000 infective larvae of *Oesophagostomum dentatum.* This animal was killed 26 days after experimental infection. Numerous raised nodules containing *Oesophagostomum* larvae were found throughout the cecum and colon. It is also of importance to note that the liver of this rabbit showed a small pearly-white, raised cyst, 1 mm. in diameter, embedded under the capsule of the liver. Upon opening the cyst there was found in it a third-stage larvae of *O. dentatum.* The possibility that these larvae may also migrate to the liver of the normal swine host still remains to be determined.

2. The occurrence of EIMERIA TRUNCATA *in the United States.* E. A. ALLEN.

The first report of the occurrence of *Eimeria truncata* in the United States was made by Dr. S. H. McNutt (1929) of Ames, Iowa, who found this protozoan parasite infesting the intestines and kidneys of goslings. In June, 1932, *E. truncata* was found infesting the intestines and kidneys of 4 to 6 weeks old goslings in Washington, D. C. Sections of the intestines of infected birds showed that these coccidia had invaded the intestinal mucosa.

3. The pathogenicity of EIMERIA MITIS *Tyzzer, 1929, to three-month-old chickens.* E. A. ALLEN.

In his description of infections of chickens with *Eimeria mitis,* Tyzzer (1929) states that there was no marked change in the general appearance or activity of infected chickens and that on post-mortem examination there were no visible lesions in the intestine. In a group of nine Rhode Island Red chickens which had been used for experimental infection with tapeworms there occurred an outbreak of coccidiosis, with marked clinical symptoms, when the birds were

three months old. Seven of these chickens had a pure infection of *E. mitis* and two had mixed infections of *E. mitis* and *E. tenella.* Six of the 7 chickens having a natural infection of *E. mitis* also were infected with nematodes or cestodes, or both. One of the two chickens having mixed infections of *E. mitis* and *E. tenella* had a few tapeworms and a few *Ascaridia;* the other bird had no worm parasites. Five of the chickens, having no coccidia other than *E. mitis,* were heavily infected with this coccidium. Three of the five birds evidently recovered from the infection, since at the time of necropsy, only a few oocysts of *E. mitis* were found in the small intestine of each bird. One of the two that did not recover was killed when nearly dead; it had no other parasites. The birds which had heavy infections of *E. mitis* were weak and passed blood during the highest peak of the infection; one of them died. The writer believes the severe hemorrhages and diarrhea observed in this group of 7 chickens were due to coccidia, *E. mitis,* since past experience has shown that intestinal hemorrhages, causing bloody diarrhea, are not associated with infections of nematodes or cestodes. These observations indicate that *E. mitis* is pathogenic to chickens.

4. The effect of various dilutions of derris extract and rotenone upon the stem or bulb nematode (Tylenchus dipsaci *Kühn*). Corinne Cooper.

In recent years derris extract, one of the active agents of which is rotenone, has been studied for its toxicity to insects with the result that it is widely used as an insecticide. This led to the question as to its effectiveness as a nematicide especially for the control of plant infesting nematodes in the soil. The following tests were made to determine the degree of toxicity of both derris extract and rotenone on one such plant infesting nematode species, namely *Tylenchus dipsaci.*

An acetone extract of derris was used with a rotenone content of approximately 5 grams to 100 cc. of extract, and with 18.1 grams of total solids per 100 cc. of extract. It was first necessary to determine what strength of solution of acetone in water the nemas would tolerate. This was found to be 25 per cent. The above extract was diluted with water until the rotenone concentration was 1 part in 5000. *Tylenchus dipsaci,* in all stages of development (approximately 200 nemas to each test), survived in this concentration at least 3 days. In no instance were the specimens which were used in the tests kept over 3 days. In a dilution of 1 part of rotenone to 1000, the nemas lived at least 3 days. In a dilution of 1 part rotenone to 500, the nemas lived at least 3 days. In these two instances, the acetone concentration did not exceed 4 per cent.

In making up solutions of pure rotenone, acetone was used as a solvent and tannic acid as a buffer, in the following proportions: 2 grams rotenone, 2 grams tannic acid, and 100 cc. of acetone. This gives an approximate 2 per cent solution of rotenone. From this, by diluting the solution with water, a 0.25 per cent solution of rotenone was prepared. The acetone concentration at this strength was approximately 12.5 per cent. *Tylenchus dipsaci* were placed directly in this solution and were removed from the solution 24 hours later, apparently unharmed. The next dilution tested was a 0.5 per cent solution of rotenone. Likewise the tannic acid was approximately 0.5 per cent but the acetone was 25 per cent. However, the specimens, when placed in this solution and left undisturbed, remained apparently unharmed for 5 days. Greater concentrations than this were not tried, first, because the acetone concentration itself would have exceeded 25 per cent, and second, because it would be economically impractical as a means of controlling *Tylenchus dipsaci.*

These preliminary tests show that derris extract and rotenone fail to injure *Tylenchus dipsaci* even in the strongest feasible concentrations.

5. Habronema incerta *(Smith, Fox and White, 1908) Gendre, 1922, in a new bird host and in a new locality.* Eloise B. Cram.

In the course of an investigation of Gambel quail (*Lophortyx gambeli gambeli*), conducted at the University of Arizona, Tucson, Arizona, there were

collected from the proventriculi of a considerable number of birds, by D. M. Gorsuch, specimens of a nematode which has been identified as *Habronema incerta:* E. E. Wehr collaborated with the writer in making the specific identification. In two cases the proventriculi, as well as the worms, were submitted to us; there was considerable destruction of the glandular tissue and the worms were located in ulcers or were entwined in the sloughing mucosa. Gorsuch noted, however, that the infested birds had appeared in good health when collected by him.

Previous records of *H. incerta* have been solely from the Philadelphia Zoological Gardens. An enzootic among parrots occurred during the years 1906 to 1915; 135 parrots died from the parasitism in that period. Additional infestations occurred in parrakeets, in pigeons and in a valley quail (*Lophortyx californica*), this gallinaceous bird being closely related to that of the present record. Smith (A. J.) in 1908 first used the name *Spiroptera incerta* but as a *nomen nudum,* the description of the species being given in succeeding pages of the same publication by Smith, Fox, and White; these three writers should therefore be credited with the species, rather than Smith alone, as has been done in the past. Weidman in 1915 elaborated on the pathological features and on the control of the enzootic. He noted that as a result of the presence of the nematodes there was destruction of the glands of the proventriculus, obstruction of passage of food, rupture of the proventriculus and subsequent serositis, and severe toxemia. The disease was controlled by hygienic measures and by detecting and isolating infected birds. Therapeusis was inefficient. Examination of all newly received parrots, since the parasite was discovered, had not brought to light a single case of infestation at the time of arrival of the birds.

Since that time Canavan in 1929 and 1931 has added new host records for the parasite, from the same zoological gardens. The astonishingly wide range of bird hosts, which have been reported as harboring *H. incerta,* now covers 8 orders of birds, namely *Psittaciformes* (parrots, etc.), *Columbiformes* (pigeons), *Galliformes* (quail), *Cuculiformes* (a touraco), *Gruiformes* (sun bittern), *Passeriformes* (tree pie), *Piciformes* (barbet and toucan) and *Rheiformes* (Rhea). That other species of *Habronema* in birds may not be narrowly restricted in their host range is indicated by the record of *H. pileata* Walton, 1927, from the bobwhite quail, after its original description from the pileated woodpecker. The specimens of *H. pileata* from the bobwhite have been compared with those of *H. incerta* from the Gambel quail and significant morphological differences, such as are described for the two species, were observed.

H. incerta varies considerably in size in different bird hosts. In collections made at the Philadelphia Zoological Gardens, the average length of males was 8 mm., of females 14 mm.; the minimum length was about half the average length in both cases, whereas the maximum length was 14 mm. and 20 mm. for the two sexes, respectively. Of the specimens from the Gambel quail, the males measure 8 mm. to 10 mm. and the females 15 mm. to 17 mm. in length; the spicules in a male about 10 mm. long are 360 μ and 1.05 mm. long, respectively, and in two males about 8 mm. long, the spicules are 320 μ and 920 μ, and 320 μ and 990 μ, respectively, the long spicule thus being approximately 3 times the length of the short spicule. The spicule lengths of *H. incerta* were not given in the original description; Canavan records them as 660 μ and 2.03 mm. but he does not state the total length of the male specimen, or the host from which it was collected. His measurements differ considerably from those made on the specimens from the Gambel quail; however, the relative lengths of the two spicules are approximately the same in both cases.

The only evidence as to the locality from which the parasite was imported into the Philadelphia Zoological Gardens might be derived from the fact that Guatemalan amazons were the first birds found to be infested; one of the infested birds died within 2 days after its arrival. The present record from the south-western part of the United States suggests the possibility of an extension of the infection into this country from Mexico, a neighbor of Guatemala.

6. A summary of 918 Chordate dissections for parasites. F. J. MEGGITT.

The following table is a summary of 918 Chordate dissections for parasites, from 1923 to 1932, showing the extent to which helminths parasitize the fauna of Burma. As may be seen, the percentage of animals uninfected is remarkably small. Unfortunately the table gives no conception of the degree of infection which is usually great.

TABLE I

	Mammalia	Aves	Reptilia	Amphibia	Pisces	Total
Cestoda	100	130	156		44	430
per cent	57.1	53.3	52.7		26.8	46.9
Trematoda	11	22	59	6	49	147
per cent	6.3	9.0	20.3	13.3	32.3	16.0
Nematoda	75	64	169	37	53	398
per cent	42.9	26.2	58.3	82.2	44.0	43.3
Acanthocephala	5	14	33	3	41	96
per cent	2.9	5.7	11.4	6.6	25.0	10.5
Pentastomida .	2	0	50	5	0	57
per cent	1.1	0	17.3	11.1	0	6.2
Uninfected	32	71	62	3	42	210
per cent	18.3	29.1	21.4	6.6	25.6	22.9
Total number of dissections ..	175	244	290	45	164	918

7. On the status of the genus DACNITOIDES. JUSTUS F. MUELLER.

Tornquist, 1931, has sensed the general similarity of *Dacnitoides cotylophora* to the species of the genus *Dichelyne,* Jagerskioid, 1902. He has determined that the intestinal cecum is dorsal and on the strength of this character has transferred the species to the earlier genus as *Dichelyne cotylophora* (Ward and Magath, 1917). Because of the inadequate material Tornquist was unable to determine the correctness of the assertion of Ward and Magath that only one ovary is present in *D. cotylophora,* but expressed doubt concerning the validity of this observation. I have been able to determine that both ovaries are present in both American species, *Dichelyne cotylophora* and *Dichelyne robusta* (Van Cleave and Mueller, 1932) new comb., both of which were originally described as members of the genus Dacnitoides. Thus there is complete agreement between the genera Dacnitoides and Dichelyne and the former is definitely reduced to synonymy.

8. Skin penetration tests with infective larvae of the swine kidney worm, STEPHANURUS DENTATUS. L. A. SPINDLER.

As a result of a series of tests, Schwartz and Price (1929 and 1931) concluded that while the infective larvae of the swine kidney worm are able to penetrate the scarified, or abraded, skin of pigs, these larvae are unable to penetrate the intact skin of the host animal. In contrast to this, Ross and Kauzal (1932) reported that they had been able to infect pigs with kidney worms by spreading soil and feces cultures of infective kidney worm larvae on the intact skin of the animals. Since the question of the ability of infective kidney worm larvae to penetrate the intact skin of the host animal has become a controversial matter, two preliminary tests were run to determine the cause of the varied results obtained by the above workers. Pigs which had been farrowed and kept under conditions precluding extraneous infections with kidney worms were used in each test.

In Test 1, 2 pigs were restrained in such a manner that the skin of the inguinal region was exposed. Approximately 2400 infective kidney worm larvae in water were placed on the intact abdominal skin of one animal. In the case of the second pig, a charcoal culture containing infective kidney worm larvae was

gently smeared on the intact abdominal skin. After 2 hours the dried culture material was removed and both pigs, together with a control pig from the same litter, were placed in a clean cement floored pen that was free from contamination with kidney worm eggs or larvae. At autopsy, 5 months later, the pig exposed to infection by means of culture material spread on the intact skin was heavily infected with kidney worms. The pig exposed to infection by means of kidney worm larvae in water placed on the intact skin, the method used by Schwartz and Price, was uninfected. The control pig was also uninfected.

In Test 2, approximately 2000 infective kidney worm larvae in a small amount of water were placed on the intact, hairless skin of the abdomen of one pig, and a like number of larvae in water was placed on the hairy portions of the body of a second pig. In the case of a third animal, a soil and feces culture containing an estimated 2000 infective kidney worm larvae was spread over the intact abdominal skin. At the end of 2 hours the culture material was removed and the pigs, together with a control from the same litter, were placed in a cement floored pen. At autopsy, 3 months later, the pig on which the culture material had been spread was infected with kidney worms. The other two pigs as well as the control pig were uninfected.

The above results indicate, as was found by Schwartz and Price, that infective kidney worm larvae in water on the intact skin of pigs are unable to infect these animals. On the other hand, the fact that infection occurred when cultures containing infective larvae were spread on the intact skin of pigs indicates that some unknown factor, probably traction, plays a part in the penetration of intact skin by these larvae. Additional experiments are in progress to test this hypothesis, and these will be reported in detail later.

9. *A case of heartworm* (DIROFILARIA IMMITIS) *in a Virginia dog.* PAUL C. UNDERWOOD.

The subject was an aged Great Dane dog, weighing 109 pounds, and originating at the Alexandria, Virginia, dog pound. The dog was received at the Zoological Experiment Station at Beltsville, Maryland, on March 14, 1933. When the animal was received it had a tumor, 8 inches in diameter, located in the subcutaneous tissue of the left thorax directly opposite the position of the heart. A diagnosis of hematoma was made and this was verified by hypodermic removal of 100 cc. of blood. A sample of this blood was negative for microfilaria upon microscopic examination. On March 18, 1933, 0.01 cc. of blood was drawn from the right ear vein of the dog and this contained 3 microfilaria, identified as larval forms of *Dirofilaria immitis*. An investigation of this dog's previous history disclosed that the animal had been born and raised in Alexandria, Virginia. According to the former owner of the dog, the animal had once been in the District of Columbia for a period of hours, but aside from that had never been out of Alexandria. This information indicates that the infestation of *Dirofilaria immitis* was acquired locally.

10. *The effect of N-Butylidene Chloride on colts infested with ascarids.* PAUL C. UNDERWOOD.

Five colts, 4 to 7 months of age, ranging in weight from 125.5 to 221.5 kilograms were treated with N-Butylidene Chloride at a dose rate of 0.2 cc. per kilogram of body weight, after a 36-hour preliminary fast. The drug was followed in 4 hours by a purgative dose of raw linseed oil, graduated according to the weight of the animal, the largest colt receiving 16 ounces and the smallest colt receiving 10 ounces of oil. The treatment was administered by stomach tube and caused no evident toxic reaction. The animals were allowed to feed 1 hour after administration of the oil.

An unusual point was observed in the case of 3 of the treated colts that happened to be involved in a nutrition experiment requiring the weekly recording of their weights from the time of birth. It was noted that the N-Butylidene Chloride

treatment did not exert the inhibitory effect on the growth rate of these animals such as has been reported following the use of other anthelmintics. On the contrary, these animals actually showed gains. The weights of these 3 colts varied from 125.5 to 159 kilograms. An initial loss of weight averaging 12.71 kilograms was due to the 36-hour fast before the colts were treated. During the four weeks prior to treatment, the colts showed an average weekly gain of 2.63 kilograms each. The average weekly gain for 4 weeks after treatment was 6.40 kilograms each. The colts showed a marked improvement in physical condition after treatment and passed many ascarids. Critical data on the efficiency of the treatment against ascarids are not available since the animals were not autopsied at the end of the test. Weights of the two other colts comprising the group were not recorded, but these colts also improved in condition and were benefited by the treatment.

11. Is Echinurioides (Nematoda) Thwaite, 1926, a good genus? E. E. WEHR.

The genus *Echinurioides* was based by Thwaite on the description of two male nematodes, measuring 4.2 mm. and 4.4 mm. long, respectively. These specimens had been collected from the spurwinged goose, *Plectropterus* sp., in northern Nigeria; the author's account, however, did not mention any location of these parasites within the body of the host.

While studying the figures and description of the type species, *Echinurioides plectropteri* (the only species of this genus), the present writer observed a close resemblance between the characteristics of *E. plectropteri,* as given by Thwaite, and those of the male of a species of *Tetrameres,* probably *T. fissispina.* This specimen of *Tetrameres* had been collected by the writer from the proventriculus of a lesser scaup duck in the United States. According to Thwaite, the body of *Echinurioides* bears 4 longitudinal rows of spines. The head is provided with 4 lips, two of which, the largest, are located laterally, one dorsally and one ventrally. The spicules were described as being unequal. These same characters are also present in *Tetrameres.* In addition to these characters, Thwaite states that *Echinurioides* possesses 4 cordons "which appear to arise from cuticular thickenings at the base of the lateral lips and run backward, one on each side and close to the lateral lines, to terminate about 100 μ from the anterior extremity; they are extremely fine and slender and do not anastomose on the lateral surfaces posteriorly." Structures lying close to the lateral lines and similar in nature to the "cordons" described by Thwaite in *Echinurioides* were observed to be present in male specimens of the genus *Tetrameres,* but they did not appear to be of the nature of cordons, as those structures occur in representatives of the subfamily *Acuariinae.* Histological cross sections of the anterior ends of male specimens of *Tetrameres* showed that the lateral ala on each side of the body from the base of the lips to a distance about half way to the cervical papilla, is divided into three parts; from this point to the posterior extremity of the body the lateral ala is single. The writer believes that the "cordons" described in *Echinurioides* are identical with the dorsal and ventral divisions of the lateral alae seen in *Tetrameres.* He also believes that the long bifid spine mentioned by Seurat (1918) and by Canavan (1931) as being present in *Tetrameres fissispina,* is not a spine; it is the same structure that Thwaite calls "cordons" and which the writer has found to be dorsal and ventral portions of the lateral alae.

Since only males of the genus *Echinurioides* were found by Thwaite, and since the bodies of the nematodes of this genus are covered with 4 longitudinal rows of spines which are especially concentrated at the extremities, and since the general morphology of *Echinurioides* and *Tetrameres* are identical, in-so-far as is able to be determined from the descriptions, it is here concluded that the genus *Echinurioides* Thwaite, 1926, is a synonym of the genus *Tetrameres.* Whether the males of all the species of the genus *Tetrameres* show the same division of the lateral alae into three parts is not certain at this time.

12. The influence of a vitamin A deficient diet on the development of TOXOCARA CANIS *in the dog.* W. H. WRIGHT.

Two dogs, 2 and 3 years of age, respectively, were freed of intestinal parasites, and maintained in such a manner as to prevent extraneous parasitic infestation. Two separate feedings of 5,000 embryonated ova of *Toxocara canis* failed to infect the animals while they were on a normal diet, as determined by the Lane D. C. F. method. At the time when the animals were showing pronounced symptoms of a vitamin A deficiency, they were each fed 520 embryonated ova of this parasite and one week later were each given 640 such ova. One animal died from the effects of vitamin A deficiency 108 days after being placed on the ration and 32 days after the first feeding of embryonated ova. No ascarids were found in the intestinal tract but ascarid larvae were present in the lungs. The second animal was killed 148 days after being placed on the vitamin A deficient ration. Four mature *Toxocara canis* were recovered from the small intestine.